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ABSTRACT

This curriculum guide consists of materials for use in teaching an advanced course in agricultural mechanics designed for 11th and 12th grade students. Addressed in the individual units of the guide are arc welding; oxy-acetylene welding; soldering; electricity; tractor maintenance, operation, and safety; small engines; farm structures; and cold metal. Each unit includes a series of lessons that contain some or all of the following: student objectives, a list of suggested teaching materials, a list of materials and audiovisual equipment necessary to teach the course, suggestions for field trips, student motivation techniques, a lesson outline, suggested student activities, and transparency masters.

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STATE OF LOUISIANA
DEPARTMENT OF EDUCATION

BULLETIN NO. 1725

THE ADVANCED PROGRAM OF VOCATIONAL
AGRICULTURE IN LOUISIANA
AG III and AG IV
(11th and 12th grades)

Issued by
Office of Vocational Education

Elaine Webb, Ed.D.
Assistant Superintendent

Thomas G. Clausen, Ph.D.
State Superintendent

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FOREWORD

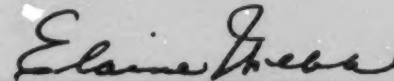
This curriculum guide is a result of extensive work on the part of numerous agricultural educators. The materials included here were developed for the express purpose of aiding secondary vocational agriculture teachers. The hope is that by having practical and usable teaching materials in their hands, teachers will be able to make improvements in their instructional program as well as have increased time available to spend on other phases of the total vocational agriculture program.

Thomas G. Clausen
Thomas G. Clausen, Ph.D.
State Superintendent
Department of Education

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Other highly significant contributors to this project include Dr. Charles W. Smith, Dean of the College of Education, Louisiana State University, who initiated the original project; Dr. Loy H. Dobbins, who effectively supervised the day-to-day activities of the project in serving as project coordinator; Mr. Thomas L. Grady, whose hard work and contributions as a member of the writing team, proofreader, and coordinator of the project in its later stages were invaluable to the successful completion of this guide; Dr. Clarence E. Ledoux, who provided invaluable support, encouragement, and advice for the completion of the project; Dr. Charlie M. Curtis, Former Director of the School of Vocational Education and Technology and Head of the Department of Agricultural Education, who made available innumerable resources of the School and Department to facilitate and support the completion of this project; Mrs. Anne Nolan who worked diligently and skillfully in preparing and revising the materials as needed; Mrs. Florence Larguer and Mrs. Mary McMinn, who willingly assisted with the preparation of materials whenever called upon; Mrs. Yvette Chandler, who so skillfully prepared the many illustrations included in the guide for use in making transparencies; Mr. J. C. Simmons, State Supervisor of Vocational Agriculture, and Mr. Robert Simmons, Mr. Russell Sullivan, and Mr. Gus Miller, Vocational Agriculture supervisors, who supported the project both directly and indirectly by willingly participating in work sessions whenever called upon to do so, and by outwardly backing the project with the teachers in the state; a special acknowledgement to the Curriculum Materials centers at AAVIM (American Association of Vocational Instructional Materials), Texas A&M University, and Oklahoma State University. These centers made numerous contributions to this project by allowing relevant materials already in existence to be freely adapted for use in this curriculum guide.



Elaine Webb, Ed.D.
Assistant Superintendent
Department of Education

MEMBERS OF ADVANCED VOCATIONAL AGRICULTURE CURRICULUM WRITING TEAM

AREA -- Agricultural Mechanics

Thomas L. Grady
Graduate Research Associate
Louisiana State University
School of Vocational Education
Room 208 Stubbs Hall
Baton Rouge, LA 70803
(504) 388-5748

Steve Woodley
Graduate Research Associate
Louisiana State University
School of Vocational Education
Room 208 Stubbs Hall
Baton Rouge, LA 70803
(504) 388-5748

Lane Beard
Graduate Research Associate
Louisiana State University
School of Vocational Education
Room 208 Stubbs Hall
Baton Rouge, LA 70803
(504) 388-5748

J. D. Richmond
Vocational Agriculture Teacher
Broadmoor Senior High School
10100 Goodwood Blvd.
Baton Rouge, LA 70815

Henry Mills
Vocational Agriculture Teacher
Arnaudville High School
Box 70
Arnaudville, LA 70512

AREA -- Agribusiness

Ganeson Velupillai
Graduate Research Associate
Louisiana State University
School of Vocational Education
Room 208 Stubbs Hall
Baton Rouge, LA 70803
(504) 388-5748

Susan S. Camp
Graduate Research Associate
Louisiana State University
School of Vocational Education
Room 208 Stubbs Hall
Baton Rouge, LA 70803
(504) 388-5748

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INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Arc Welding

LESSON 1: Safety

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the fundamental safety rules and procedures associated with arc welding.
2. Specific:
 - a. Describe the protective equipment used in arc welding.
 - b. Name four rules associated with ventilation in arc welding.
 - c. Explain the consequences of welding on a container or drum.
 - d. Describe the steps in fire protection associated with arc welding.
 - e. List several rules associated with arc welding in the following areas:
 - 1) Installation of arc welder,
 - 2) Safety equipment,
 - 3) Work area,
 - 4) Miscellaneous, and
 - 5) Maintenance.

B. Review of Teaching Materials

1. Phipps, L. S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.
2. McCoy, V. L. and T. J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

Arc welding gloves, helmet, apron and/or sleeves, and other safety items and equipment used in arc welding.

D. Materials Required

1. Overhead projector and screen.
2. Materials listed above.

II. Presentation of Lesson

A. Motivation

A welder is constantly exposed to two eminent dangers, which, if not properly handled, can result in serious injury or even death. These two dangers emerge because the welder is working with an electrical current (that, under certain conditions, can provide a hazardous shock) and an open flame (produced by the arc). Therefore, it is imperative that the beginning welder follow and understand the safety rules associated with arc welding.

B. Content Outline

1. Arc welding safety will be discussed under the following headings:

a. Protective Equipment

- 1) Always wear a head shield or helmet with suitable filter plates or lenses when arc welding. The welding helmet is designed to protect the eyes from sparks and slag, and also from ultra violet rays of the flame or arc. The helmet also helps the welder see the work better.
- 2) Always wear protective goggles when chipping and/or grinding welds.
- 3) Wear leather or asbestos gloves, aprons, and proper shoes. (Transparency I-1-A)
- 4) Keep all protective clothing dry and free from oil.
- 5) Keep all pockets and cuffs of protective equipment closed or buttoned.
- 6) Never weld with a lighter or matches in the pockets of a shirt or trousers.

b. Ventilation

- 1) Always be sure that the welding area is properly ventilated. (Transparency I-1-B) If toxic fumes are to be encountered, use an air-supplied respirator. Make sure there is no concentration of oxygen in the welding area.
- 2) Never use oxygen for ventilation. Always use air for ventilation purposes.
- 3) Do not weld or cut for at least 15 minutes after protective clothing has been contaminated with oxygen.
- 4) Never use oxygen as a substitute for air to "blow off" dust or dirt.

c. Tanks and Containers

- 1) Do not weld or cut containers such as drums, barrels, and tanks, until it is known that

there is no danger of fire or explosion. Welding on containers should be done only by welders familiar with the American Welding Society's standard practice recommendations (A.W.S.-A6.0-65).

- 2) Do not depend upon smell to determine if the residue in a barrel or drum is toxic; find out exactly what was in the barrel or drum.
- 3) A very small amount of residue can cause an extremely large explosion and serious injury.
- 4) Never use oxygen to ventilate a container.

d. Fire Prevention

- 1) Fire may result from arc welding if combustible materials are too close to the welding operation. It only takes one spark or hot piece of molten metal to ignite several different types of materials found around most agricultural shops.
- 2) Always remember:
 - a) Sparks from the arc welder have been known to travel up to 35 feet.
 - b) Most of the falling slag from the welding procedure falls out of sight of the welder and is potentially dangerous.
 - c) The base metal that is being welded reaches temperature hot enough to ignite combustible materials that it may be in contact with.
- 3) To prevent fires:
 - a) Weld only in an area (if possible) that is completely free of combustible materials.
 - b) Weld with the "buddy system." Always try to have someone who is not welding to monitor while the welding process is taking place to watch out for fires that may cause serious damage to equipment and people.
 - c) Always inspect the area after welding to ensure there are no hot pieces of metal or glowing sparks left.

2. Obey the following safety practices when using the arc welder:

a. Installation of the arc welder

- 1) A certified electrician should install the welder to ensure that proper electrical connections and wiring techniques are used. The switch box or disconnect switch should be within reach of the welder. Check the frame on the welder to determine if it is properly grounded.
- 2) Make certain the handle of the electrode holder and all electrical connections are properly insulated.
- 3) Use only rubber-covered cable, free from splices for at least 10 feet from the electrode holder.
- 4) Keep the off-and-on switch in working condition at all times.
- 5) Do not install a welder in a location that is wet or damp or has prospects of becoming wet or damp.

b. Safety equipment

- 1) Wear clothing as describe under protective equipment above. Always wear gloves.
- 2) The welder and all observers must wear proper eye protection at all times.
- 3) Wear clear-glass goggles or a lift-lens head shield when chipping and grinding welds.

c. Safety in the work area

- 1) Have available appropriate first-aid materials. Eye burns from ultraviolet and infrared rays feel as if there is hot sand in the eyes. For this, apply a drop or two of either 5 percent solution of argyrol, 2 percent solution of Butyn, castor oil, or sweet oil in the eye, followed by aspirin to stop pain. Eye burns are not usually realized until three to eight hours after the burn occurred. If the injury is serious, see a physician. Skin burns should be treated as sunburns using any commercial compound made for this purpose.

- 2) For small and practice jobs, work in a nonmetal fireproof booth to protect others from harmful light rays. Be sure the booth is adequately ventilated; the screens should be several inches from the floor for this purpose. When working outside the booth, use portable screen shields to protect others.
- 3) Try to avoid standing on any metal that is grounded to the arc welding machine.
- 4) Never weld while standing on a wet or damp floor.
- 5) Be certain the metal welding table is properly grounded and clean.
- 6) Place hot metal in a designated area to prevent possible burns and fires.
- 7) Attach an insulated holding device on the arc welding table to hold the electrode holder when not welding.
- 8) Under the welding table or in the working area, keep a container in which to deposit each electrode stub. This prevents burns to the shoes or falls because of stubs rolling underfoot.
- 9) Use a welding table and/or welding positioner to hold metal secure and in the correct position when possible. This helps to prevent injury from accidental dropping of the metal on the feet or on the body.

d. Miscellaneous safety rules

- 1) Never strike an arc until you are certain that everyone nearby is protected from the arc rays.
- 2) Do not hold the electrode holder under the arm or between the knees. Also, do not let the electrode or holder touch bare skin.
- 3) Do not dip electrode holder in water to cool it.
- 4) Keep the cables from coming in contact with hot metal or sharp edges.
- 5) If the electrode sticks, cut off switch, allow electrode to cool, and break loose with gloved hand.

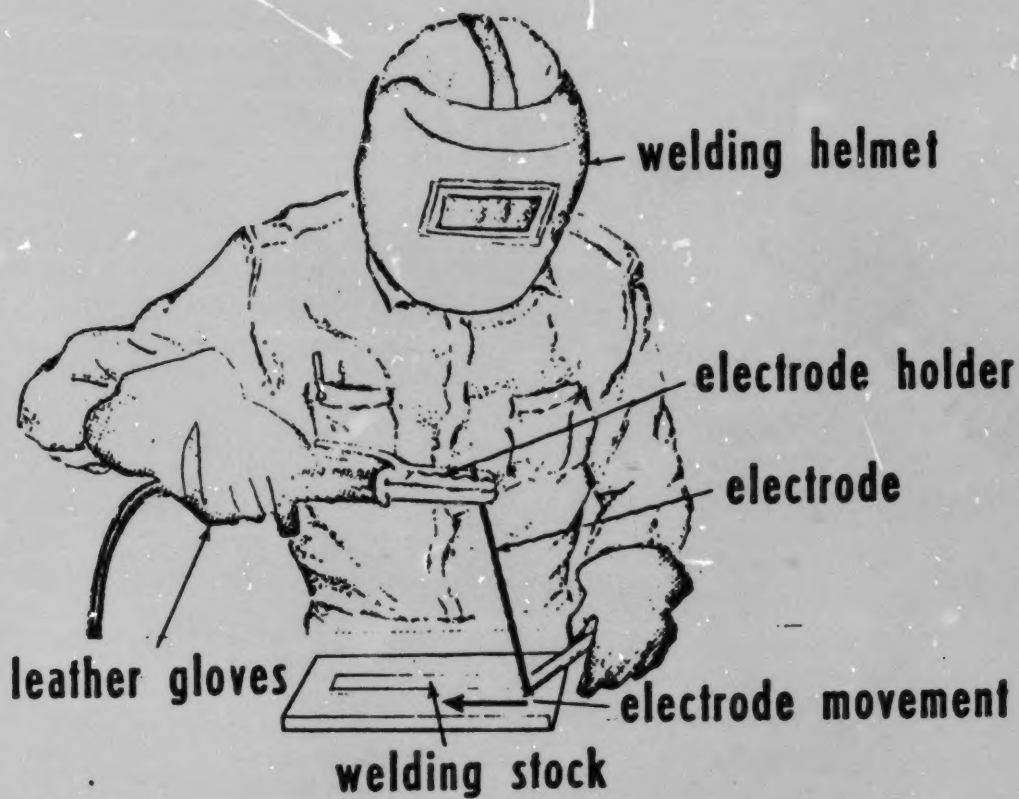
e. Maintenance

- 1) Keep all connections tight. When cables are frayed next to the plug, electrode holder, or ground, repair them by cutting off the frayed part. Resolder, or attach, and cover them the same way the manufacturer did. Never leave metal cable exposed.
- 2) Every month, blow the dust and dirt from the coils of the welder with an air hose. Do this more often if the area is dusty. Dirty transformer coils cause excessive heating, lower the efficiency of the machine, and can eventually ruin it.
- 3) Provide adequate ventilation to prevent coils from heating and moisture from condensing on and corroding electrical parts.
- 4) At least twice a year, lubricate adjustment screws and the bearing supporting the screws, if the machine is of that type.
- 5) Lubricate the bearings in any coil-cooling fans at least twice a year, unless the instruction manual specifies otherwise.
- 6) Periodically, clean and inspect contacts, switches, relays, jacks, and plug connections. Replace worn or broken parts.

C. Suggested Student Activities

Have students make a drawing of the shop, requiring a detailed drawing of the welding area(s). Include such items as the location of fire extinguishers, fire alarms, welders, combustible materials in the shop, etc.

ARC WELDING SAFETY

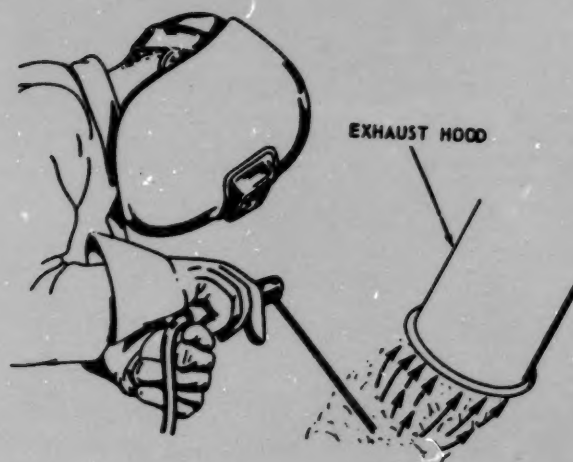


PROTECT YOURSELF



AS WELL AS OTHERS.
TRANSPARENCY I-1-A

ARC WELDING SAFETY



MAKE SURE THERE IS PROPER VENTILATION
IN THE WELDING AREA AT ALL TIMES.

TRANSPARENCY I-1-B

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Arc Welding

LESSON 2: Metal Identification

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the techniques used to identify various types of metal associated with welding.
2. Specific:
 - a. List the three variables that affect the properties of steel.
 - b. Describe the basic procedure involved in each of the following tests to identify various metals.
 - 1) Spark
 - 2) Torch
 - 3) Fracture
 - 4) Color
 - 5) Density
 - 6) Ring
 - 7) Magnetic
 - 8) Chip

B. Review of Teaching Materials

1. Phipps, L. S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.
2. McCoy, V. L. and T. J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Some of the tests used to differentiate between various metals in this lesson require specific equipment. The instructor may wish to have this material available to show the students.
2. Have on hand various types of metals.

D. Materials Required

1. Overhead projector and screen
2. Materials listed above

II. Presentation of Lesson

A. Motivation

In order for a welder to select the proper electrode and heat range, he must know the composition of the base metal to be welded to ensure a quality weld. There is a big difference in welding on mild steel, cast iron, and aluminum, just to name a few examples. Therefore, the welder has to be able to identify the metals to be welded.

B. Content Outline

1. The properties of steel are affected by three variables--carbon content, temperature, and time. A welder has to be able to identify various types of metal to ensure that the right electrode will be used as well as the right amperage range. The best way to determine the type of metal is through the manufacturer's specifications, but most likely these specifications will not be readily available to the welder. Therefore, there are several, eight in all, different tests that can be performed to determine what the characteristics of the metal are, thereby enabling the welder to identify the metal. The most common tests for shop use are the following:

- a. Spark test -- This method is widely used by welders to identify various irons and steel. The only piece of test equipment required is a stationary or portable grinder. The metal is simply placed in contact with the grinder and the sparks that are sent off from this contact are observed and analyzed. Four characteristics of the sparks generally will tell the welder the nature and condition of the steel. They are as follows:

- 1) Color of the spark,
- 2) Length of the spark,
- 3) Number of explosions along the length of the individual sparks, and
- 4) Shape of the explosions--whether or not the sparks are forking or repeating.

To recognize the following different types of metal using the spark test, see Transparency I-2-A and B:

White and Gray Cast Iron	Tool Steel
Malleable Iron	Alloy Steel
Wrought Iron	Nickel
Mild Steel	

- b. Oxy-acetylene torch test -- Is used to determine if the metal has good welding characteristics or the weldability of the metal. Impurities imbedded in the metal in form of slag or excessive sulphur and phosphorus will result in a piece of metal having poor welding characteristics. The procedure

consisting of melting a puddle in the steel and observing how the molten puddle reacts. The puddling should be done with a neutral flame. The puddle should not give excessive sparks and should be fluid. The puddle should not boil, but possess good surface tension. If a shiny appearance is noticed after the metal has been allowed to cool, it is considered to have good welding characteristics. If the metal is dull or lackluster and the surface is pitted, porous, or rough, the metal is considered unsatisfactory for welding (Transparency I-2-C).

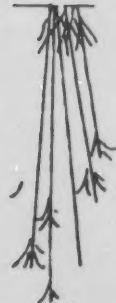
- c. Fracture test -- Is widely used and accomplished simply by breaking a portion of the metal in two. The fractured edges are inspected to determine the color of the metal, the type of grain the metal exhibits, and whether it is brittle or soft and ductile.
- d. Color test -- The two main divisions of metals include the irons and steels, which are typically gray-white in color, and the nonferrous metals, generally classified as white or yellow. Copper, brass, and bronze are easily identified by their colors.
- e. Density or specific gravity test -- Metals can be identified by their weight or density. An example is comparing the specific gravity or weight of aluminum and lead. Although these two metals may be similar in color, it is easy to differentiate them based on weight.
- f. Ring or sound test -- Sound is used to determine the difference between two pieces of metal. This procedure requires experience and the knowledge of the sounds of different types of metal. An example is the difference between aluminum and duralumin (alloy consisting of 95.5 part aluminum to 3 parts copper, 1 part manganese, and .5 part magnesium). The aluminum sheet would have a duller sound than the duralumin, which is harder and has a more distinct ringing sound.
- g. Magnetic test -- A test used to distinguish between steel and nonferrous metals. Generally, all steels are affected by magnetism and nonferrous metals are not. However, some of the stainless steels are not magnetic.

- h. Chip test -- This test requires some prior experience. A cold chisel is used to cut into the metal at an angle to indicate the structure and heat treatment of the metal. Cast iron, when chipped, breaks off into small pieces, while a piece of mild steel tends to curl and cling to the original piece (Transparency I-2-C).

C. Suggested Student Activities

Have an assortment of metals to be identified by the students based solely on the appearance of the metals.

SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL	SPARK STREAM	COLOR STREAM LENGTH
White and Gray Cast Iron		Top-Red Bottom-Straw Yellow 20" to 25"
Malleable Iron		Straw Yellow About 30"
Wrought Iron		Top-Straw Yellow Bottom-White About 65"
Mild Steel		White About 70"

SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL

SPARK STREAM

**COLOR
STREAM LENGTH**

Tool Steel



White About 55"

Alloy Steel



**Top-Straw Yellow
Bottom-White
Length Varies**

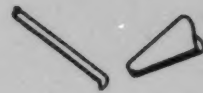
Nickel



Orange About 10"

TRANSPARENCY 1-2-B

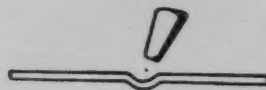
OXY-ACETYLENE TORCH TEST



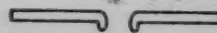
GOOD QUALITY
FILLER ROD



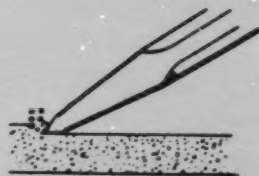
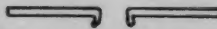
POOR QUALITY
FILLER ROD



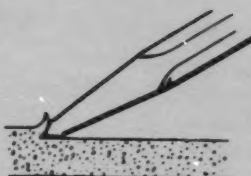
GOOD QUALITY BASE METAL



POOR QUALITY BASE METAL



Breaks Off In
Small Particles



Curls and Clings

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Arc Welding

LESSON 3: Joint Preparation

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Summarize the types of joints used in welding and the characteristics of each joint.
2. Specific:
 - a. List the five types of joints.
 - b. Describe the most common way joints are prepared.
 - c. Discuss the main reasons why metals are beveled.
 - d. List the steps in joint preparation.

B. Review of Teaching Materials

Kennedy, G. A. Welding Technology. Indianapolis, Ind.: Bobbs-Merrill Educational Publishing, 1978.

C. Special Arrangements

1. Display of the five types of joints
2. Equipment used in joint preparation such as the oxy-acetylene torch, portable and/or stationary grinders, files, etc.

D. Materials Required

1. Overhead projector and screen
2. Materials listed above

II. Presentation of Lesson

A. Motivation

Since it is necessary for the welder to prepare materials before they are welded, it is important to know the

different types of joints, how they are prepared, and some of the advantages and disadvantages of each type of joint. The quality and strength of the finished project will depend greatly on the welder's ability to prepare the metal properly.

B. Content Outline

1. The types of joints used in oxy-acetylene welding and arc welding can be classified as lap, edge, tee, butt, and corner, as shown in Transparency I-3-A.
 - a. Lap -- The lap joint is two overlapping pieces of metal fused together by such welding processes as spot, plug, slot, or fillet welding.
 - b. Edge -- The edge joint is made by placing the surface of one piece of metal to be welded on or against the surface of the piece to be joined, so that the weld is located on the outer planes of both parts.
 - c. Tee -- The tee joint is welded by placing the edge of one piece of metal on the surface of the other to form a 90° angle. This forms a shape that is similar to the letter "T," hence its name.
 - d. Butt -- The butt joint is when two pieces of metal are simply "butted" together so that the bead is between the surface planes of both fused parts. When joints are prepared and welded from both sides, they are classified as double joints.
 - e. Corner -- The corner joint is so classified because the two pieces of metal are placed 90° to each other in the form of the letter "L." Corner joints can be prepared by grinding, machining, or flame cutting. Corner joints can also be classified as half-lap, corner-to-corner, and full inside.
2. Most on-the-job preparation is done by using the oxy-acetylene cutting process and portable electric power grinders. Carefully controlled oxy-acetylene equipment, such as a radiograph (copy or pattern torch), is an excellent way to prepare joints for fabrication. This method may only be done in the shop, which is a major disadvantage.

The square groove joint is the most economical but is often good only for products that are to be made of light-gauged material.

When metal is beveled, the cost is higher. However, there is often no alternative, especially if heavy plates are to be welded. Without proper edge chamfering, complete penetration is impossible and without good penetration, the resulting weld joint will be weak.

For the greatest economy, select a root opening and groove angle that requires the least amount of filler material.

3. Factors to consider in joint preparation are listed below:

a. Select the type of joint using the following criteria:

- 1) Load intensity, impact stress, compression, tension, fatigue, and warping
- 2) Cost of the finished product. The lowest-priced joint will require the least bead fill.
- 3) Cut or manufactured joints
 - a) Check to ensure that all slag and foreign materials have been removed (such as dirt, rust, paint, etc.) from the surface of the joints to be welded.
 - b) Check to ensure that the joints fit together properly before they are welded.
 - c) Determine what type of "passes" (beads) will be used to give the joint the strength and characteristics called for.

4. Advantages and Disadvantages of Various Joints

a. Edge joint--

Advantages

For simpler loads, the edge joint is fairly easy to weld.

Disadvantages

- 1) It is not practical for structures to be subjected to high intensity loading.
- 2) Where impact or stress-causing fatigue is possible, a weld other than the edge joint should be considered.

b. Butt joint--

Advantages

Joints which will be required to withstand fatigue, stress, shock, or bending should be prepared as butt joints, rather than single- or double-fillet lap joints.

Disadvantages

- 1) A major disadvantage of butt joints is that they are more costly than lap joints.
- 2) Butt welds will present a greater problem to the welder than will fillet welds when used with the lap joint.

c. Groove-weld joints--

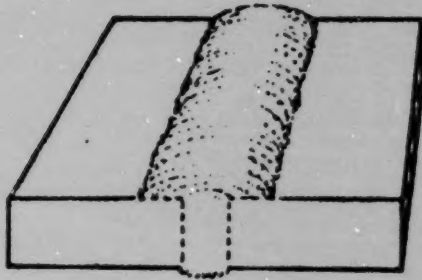
The root opening, root face, and groove angles, should be designed to give complete penetration and maximum strength, with the least amount of electrode metal. Groove-weld joints take in the groove angle, root face, and root opening for considering the weld's entire penetration.

Regardless of the type of preparation on the joint, weld strength depends on whether complete joint preparation has been accomplished during welding.

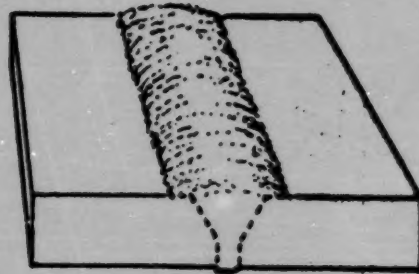
C. Suggested Student Activities

1. Have the students arc weld the joints described in this lesson. At the completion of each joint, require that they turn in a written assignment on the procedure followed to make and weld the joint. List advantages and disadvantages to each joint (which ones were hard to weld and why).
2. In preparing a joint using the oxy-acetylene cutting torch, have the student weld the joint(s) without the aid of a grinder. This will encourage the student to become proficient at using the torch correctly.

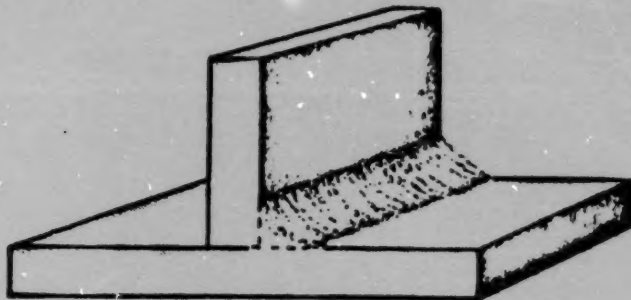
COMMON TYPES OF WELDS AND JOINTS



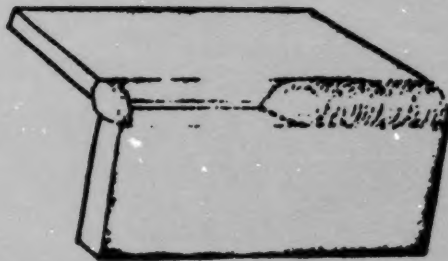
BUTT WELD



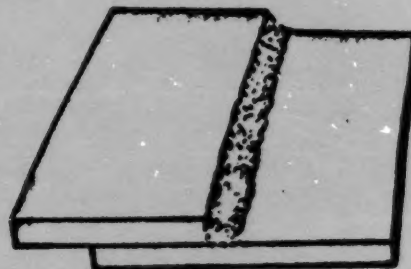
BEVELED BUTT WELD



TEE WELD



CORNER WELD



LAP WELD

TRANSPARENCY I-3-A

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Arc Welding

LESSON 4: Welding Pipe

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the areas that use pipe welding.
2. Specific:
 - a. Name the organization that sets standards for welding pipe.
 - b. List several advantages of welding pipe.
 - c. List the four main groups of pipe welding.
 - d. Explain the term "lap collars."

B. Review of Teaching Materials

Kennedy, G. A. Welding Technology. Indianapolis, Ind.: Bobbs-Merrill Educational Publishing, 1978.

C. Special Arrangements

Have on hand various pieces of pipe, some with threaded ends, others that have been prepared for welding.

D. Materials Required

1. Overhead projector and screen
2. Materials listed above

II. Presentation of Lesson

A. Motivation

Manual shielded arc welding was used as early as 1928 to weld pipes together to construct a pipeline. Since that time, its use has increased tremendously. Pipelines are used for many commodities besides oil and gas. A welder

today will need to know many techniques that are used in welding transmission pipelines.

B. Content Outline

Pipes are manufactured from both ferrous and nonferrous metals, as well as from different types of plastics. Pipes made from ferrous metals (wrought iron, low and high alloy steels, stainless steels) are still in great demand. Wrought iron pipes are usually used where corrosion is a problem, although plastic pipes are appearing on the market and are being used, where possible.

Until recently, pipe welding qualifications have varied in different parts of North America. To stabilize pipe welding qualifications and pipe system testing, standards have been set up by the American Petroleum Institute (API). To be approved, pipe welders must pass certain tests. Today, the tests normally depend upon the pipe system codes being used by pipe system owners, engineers, and local and/or federal authorities.

Advantages of Welded Pipe

1. Material Saving -- Welded pipe fittings are now available for air conditioning, heating, refrigeration, and other plumbing jobs at a cost that is often less than threaded fittings. (Transparency I-4-A)
2. Labor Saving -- Installing a welded pipe system is quicker and easier than installing a system using all threaded pipe.
3. Strength -- A properly welded pipe system is strong, leak proof, and will usually outlast a similar system that has been put together with threaded fittings.
4. Easier Flow -- Turbulence, erosion, and clogging are greatly reduced in the welded system.
5. Insulation and Appearance -- Insulating welded systems is simple and easy, since the outside diameters of the pipes and fittings are identical. Nesting the pipes against walls and corners will give a better job appearance and save space when a welded system is used.

The pipe industry can be divided into four different groups for welding purposes. Each pipe system has its own welding requirements and specifications. The four groups include the following:

1. Subcritical Pipe Welding -- Most of the pipe and fittings are fairly small in diameter and have standard wall thickness. Low pressure heating system, air conditioning, different service installations, and simple water supply systems are all classified as

subcritical pipe systems. It is called subcritical, because little or no human danger is anticipated if a defective weld is made. For this reason, special welding qualifications are not often required for subcritical pipe welding in many places.

2. Critical Pipe Welding (Pressure and Power Systems) -- Welding pressure and power systems are classified as critical because of the high pressure that the system is usually required to withstand. Critical pipe welding is required for pipe systems in refineries, generating plants, chemical processing plants, petroleum plants, and other places where weld defects could be both costly and dangerous to human life. Welders must have special qualifications to meet pipe code requirements for this area.
3. Cross-Country Transmission Pipeline Welding -- Cross-country transmission pipelines are usually used to transport natural gas or petroleum products. The pipe sizes used varies from about 10" diameter to over 36" diameter for a main line. Weld qualification standards for transmission pipeline welding in the United States are set up by the American Petroleum Institute (API).
4. Water Transmission Pipe Welding -- Water transmission pipe welding can be done by any welder, without special welding qualifications. Water transmission pipelines come in sizes as small as 1" in diameter up to approximately 8" in diameter for main lines. Water transmission lines for crop irrigation are often made of galvanized iron to withstand corrosion. Unlike cement-coated pipes, corrosion-resistant galvanized pipes are fairly easy to install and weld.

Manual Arc Welding Water-Transmission Pipelines

The qualification tests for welding water-transmission pipelines are not usually as difficult as the qualification tests for welding critical high-pressure lines. Butt welds, similar to those used on critical or subcritical pipelines, are also frequently used to join water-transmission pipelines.

Lap Collars -- Lap joints are normally the best joints to use for joining pipe with a wall thickness of at least $\frac{3}{8}$ ". Lap collars have an inside diameter equal to the outside diameter of the pipe, allowing the pipes to be butted together and welded into a single unit with fillet welds as illustrated in Transparency I-4-B.

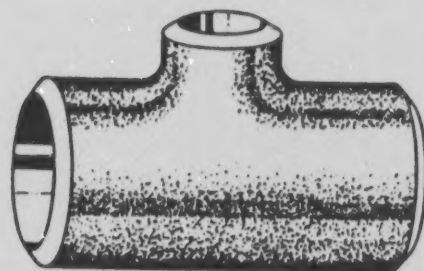
Smaller diameter water-transmission pipelines can be welded with the same techniques used for critical and subcritical

pipe systems. Generally speaking, the prepared fittings, electrodes, and positions for other pipe welding will work for water pipelines.

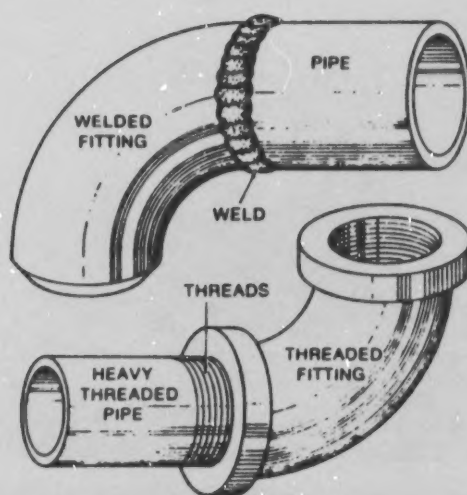
C. Suggested Student Activities

1. Have students practice arc welding on pieces of pipe.
2. Assign the students to find out what type of pipeline welding is done locally. Have the students follow up by finding out what qualifications are required for welders.

ADVANTAGES OF WELDED PIPE



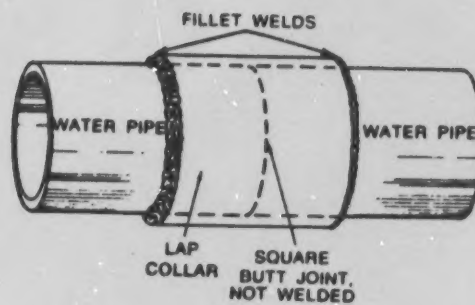
WELDED PIPE FITTINGS WITH BEVELED ENDS
PREPARED FOR WELDING.



SIMILAR PIPE JOINTS: WELDED
AND THREADED.

TRANSPARENCY I-4-A

LAP COLLAR



A LAP COLLAR MAY BE USED FOR
EASILY JOINING WATER TRANSMISSION
PIPELINES.

TRANSPARENCY I-4-B

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Arc Welding

LESSON 5: Reading Blueprints and Drawings

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Explain and identify the common symbols associated with arc welding.
2. Specific:
 - a. State the main reason why welding symbols are used.
 - b. List the three factors given by the reference line.
 - c. Explain what types of information are placed in the tail of the reference line (arrow).
 - d. Describe what the following symbols indicate:
 - 1) Reference line break
 - 2) Black dot
 - 3) Open circle
 - 4) Contour letters
 - a) M
 - b) C
 - c) G

B. Review of Teaching Materials

Kennedy, G. A. Welding Technology. Indianapolis, Indiana: Bobbs-Merrill Educational Publishing, 1978.

C. Special Arrangements

None

D. Materials Required

1. Overhead projector and screen
2. Materials listed above

II. Presentation of Lesson

A. Motivation

1. When a welder knows the common welding processes and procedures, he should also know how to read welding blueprints (instructions). Welding most common repairs and construction will be easier to understand if the welder has a knowledge of blueprints.
2. Several basic techniques are used to weld structural framework in industry. The technique may vary, depending on the job being done. Welding for repairs and welding for a new construction will require different methods. In all cases, a language known as weld symbols will tell the welder what to do.

B. Content Outline

Common symbols are used in the welding trade on instruction sheets known as blueprints. These instruct the welder what to do and where to do it. The blueprint can either be a rough-drawn or well-designed weldment plan. Both written directions and welding symbols may be included on the blueprint to tell the welder what type of joint preparation, weld bead, and other techniques are to be used for each weld. Without the use of symbols, the engineer and draftsmen would not be able to briefly tell the welder all the important information about the welding area. To write out these directions in long hand would be too costly and time consuming.

Standardized welding symbols make these directions quick and efficient. Even though only a few symbols are usually used, these save time and eliminate many long explanations.

Symbols used by draftsmen and engineers in welding are as follows:

1. Joint -- The joint is the reference point. The type and preparation of the joint, as well as the weld type, will be indicated by the symbol. The symbol itself always refers to the joint and, basically, the symbol looks like an arrow. The symbol has several parts, as follows: (Transparency I-5-A).

- a. Reference Line -- The arrow has two sides--a top and bottom--to its reference line. Weld information is on the top side of the reference line and information about the weld is on the other side, away from the arrow. Hence, top symbol side equals other weld side.

The bottom side of the arrow's reference line has information on it about the weld located on the arrow side of the joint. So, bottom symbol side equals arrow weld side.

If information on both sides of the symbol's reference line is the same, it means that both sides of the joint are to be welded the same (Transparency I-5-A).

- b. Tail -- Welding specifications and other information used to make the weld are placed in the tail of the arrow.

- c. Reference Line Break -- If the reference line has a second break in it, as Transparency I-5-B is indicating, the second break will point toward the piece of parent metal that is to receive all the preparation. The second break is used when only one piece of metal is to be prepared.
- d. Black Dot -- A black dot at the break indicates that the weld should be done on the job site, not in the shop. This is also called welding "in the field."
- e. Open Circle -- If there is an open circle at the weld break, it indicates that welding should be done completely around the project at the position indicated by the arrow. (Transparency I-5-C)
- f. Contour Letters -- Contours formed by machining, chipping, or grinding are indicated by the letters M, C, and G, respectively. If the weld is to be machined, chipped, or ground, the correct letter is placed on top of the contour symbol (Transparency I-5-C).

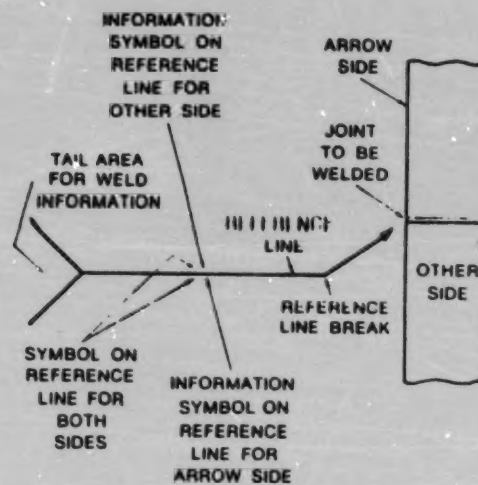
Both arc and oxy-acetylene welds use the same type of weld symbols. Transparency I-5-D shows the symbols used for each basic type of weld: groove, bead, fillet, etc. If information were for the weld near the arrowhead (arrow side), the symbols would be turned upside down.

- 2. A description and list of other welding symbols commonly used are shown in Transparencies I-5-E, F, G, H, I, J, K, and L.

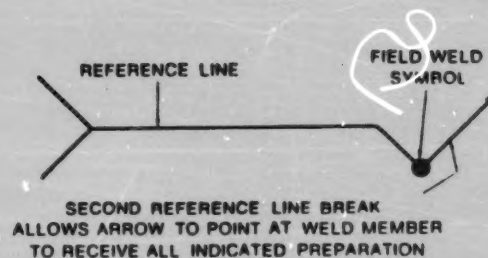
C. Suggested Student Activities

- 1. Assign the students to make a detailed drawing using welding symbols from written directions on a particular joint or piece to be welded.
- 2. Show the students a particular joint that has been welded. Have students write out in long hand what they see. Then have students use symbols to describe the same joint or joints.

WELDING SYMBOLS

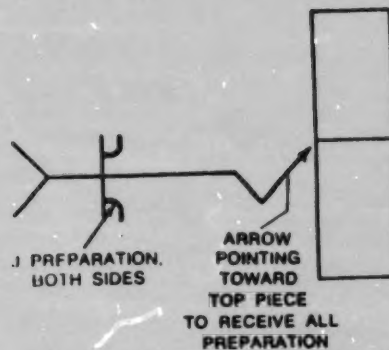


BASIC PARTS OF THE ARROW WELD SYMBOL

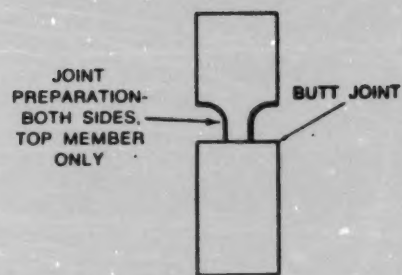


A BLACK DOT ON THE REFERENCE LINE INDICATES THAT THE WELD IS TO BE MADE IN THE FIELD.

WELDING SYMBOLS

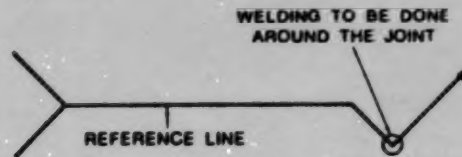


WHEN THE REFERENCE LINE HAS
A SECOND BREAK, THE SECOND
BREAK POINTS THE ARROW TOWARD
THE MEMBER TO BE PREPARED.

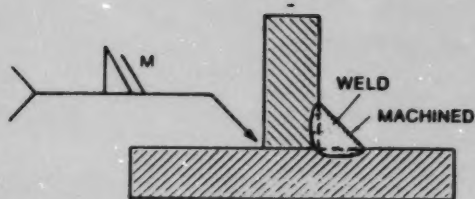


A JOINT PREPARED AS IN-
DICATED BY THE SYMBOL ABOVE.

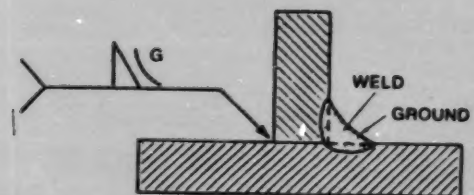
WELDING SYMBOLS



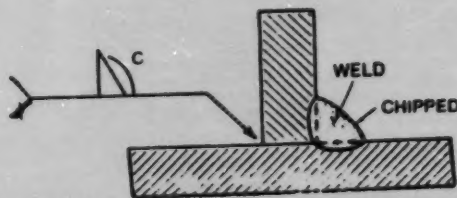
AN OPEN CIRCLE AROUND THE REFERENCE LINE BREAK INDICATES THAT THE WELD IS TO BE MADE COMPLETELY AROUND THE JOINT.



THE FILLET SYMBOL ON TOP OF THE REFERENCE LINE INDICATES THAT A FILLET WELD IS TO BE MADE ON THE OTHER SIDE OF THE TEE JOINT. THE CAPITAL M AND STRAIGHT LINE INDICATE THAT THE FINISHED WELD IS TO BE MACHINED.

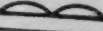


THE CONTOUR SYMBOL AND CAPITAL G INDICATE THAT THE FINISHED WELD IS TO BE GROUND.



THE CONTOUR SYMBOL AND CAPITAL C INDICATE THAT THE FINISHED WELD IS TO BE CHIPPED.

WELDING SYMBOLS

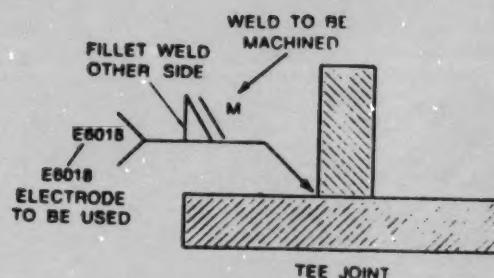
WELD DESCRIPTION	SYMBOL
PLUG OR SLOT WELD	
GROOVE WELD	 SQUARE
	 V
	 BEVEL
	 U
BEAD WELD	
BEAD (BUILD UP)	
(1) FLUSH	
CONTOURS (2) CONVEX	
(3) CONCAVE	
FIELD WELD	
WELD ALL AROUND	

EACH TYPE OF WELD, WITH DETAILS,
HAS ITS OWN WELD SYMBOL.

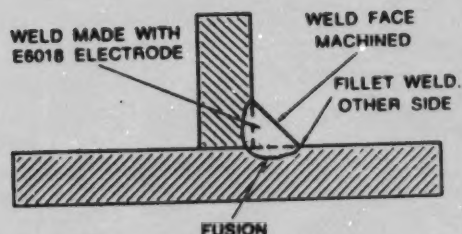
WELDING SYMBOLS

	RIGHT	WRONG
BEVEL SYMBOL		
J SYMBOL		
FILLET SYMBOL		

WHEN A SYMBOL SUCH AS A BEVEL, FILLET, OR J IS PLACED ON A REFERENCE LINE, THE VERTICAL PART OF THE SYMBOL-MUST ALWAYS BE DRAWN ON THE LEFT.

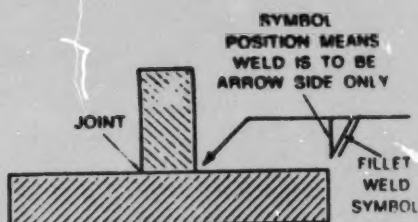


A SIMPLE TEE JOINT AND A COMMON WELD SYMBOL FOR THE JOINT.

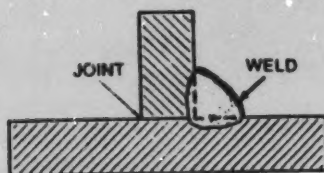


COMPLETED TEE JOINT, WELDED ACCORDING TO THE WELD SYMBOL IN THE TOP RIGHT CORNER.

WELDING SYMBOLS

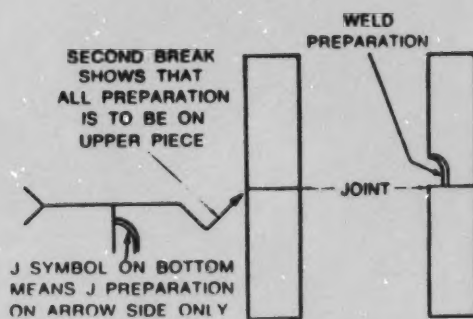


A. AS SHOWN BY A BLUEPRINT



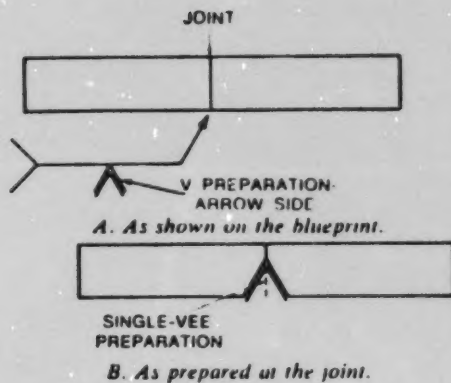
B. FILLET WELD MADE ON THE ARROW SIDE OF A TEE JOINT

A COMMON TEE JOINT, AS BLUE-PRINTED AND AS WELDED.

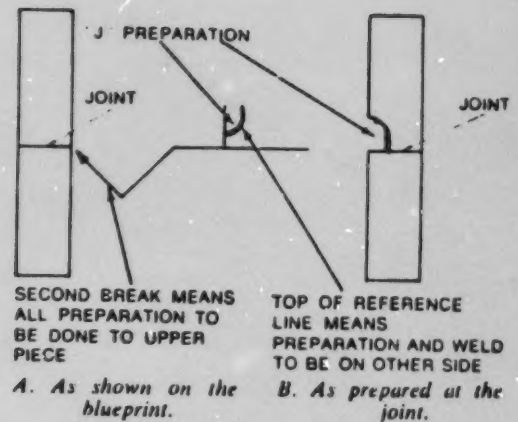


A COMMON BUTT JOINT, AS BLUE-PRINTED AND AS PREPARED.

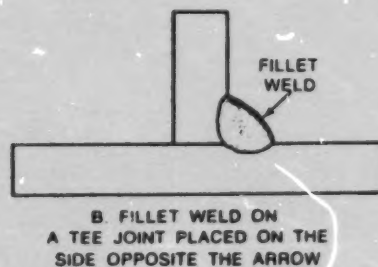
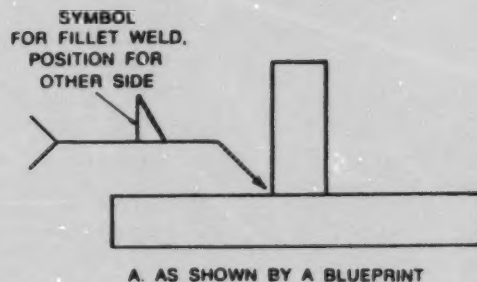
WELDING SYMBOLS



A COMMON BUTT JOINT, AS BLUE-PRINTED WITH A VEE-GROOVE AND AS PREPARED.

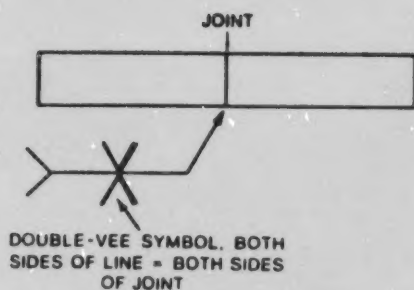


A COMMON BUTT JOINT, AS BLUE-PRINTED AND AS PREPARED.

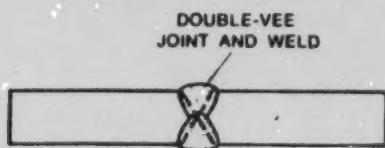


A COMMON TEE JOINT, AS BLUE-PRINTED AND AS WELDED.

WELDING SYMBOLS

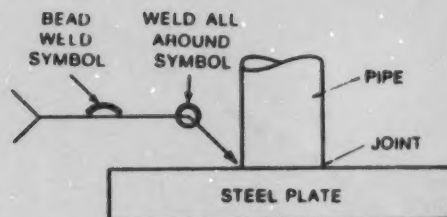


A. As shown on the blueprint.

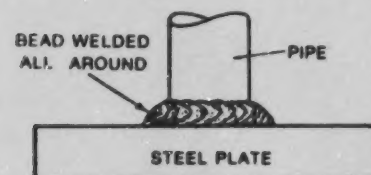


B. As welded at the joint.

A COMMON DOUBLE-VEE BUTT JOINT, AS BLUEPRINTED AND AS WELDED.

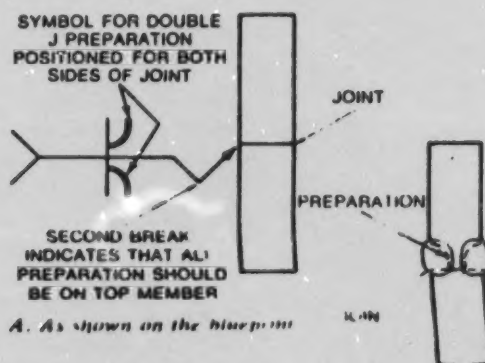


A. As shown on the blueprint.



B. As welded at the joint.

WHEN A PIPE IS TO BE WELDED TO A STEEL PLATE THE OPEN SYMBOL FOR "WELD ALL AROUND" IS OFTEN USED AS SHOWN.

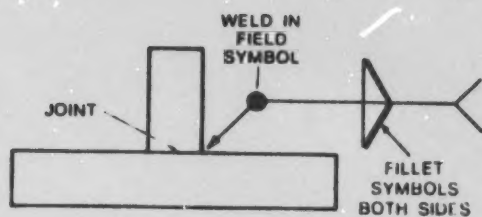


B. As welded at the joint

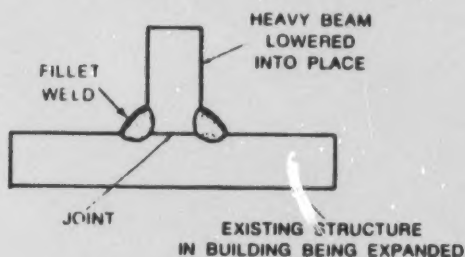
A DOUBLE-J JOINT, AS DRAWN AND AS WELDED.

TRANSPARENCY I-5-H

WELDING SYMBOLS

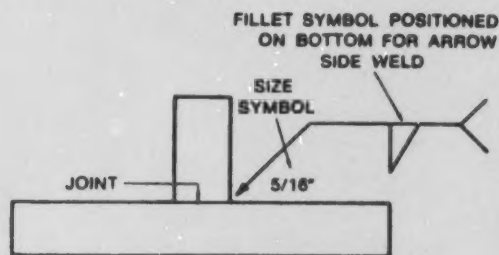


A. As shown on the blueprint.

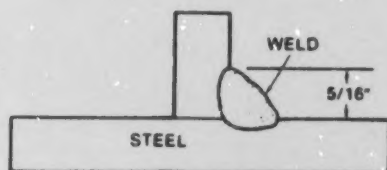


B. As welded at the joint.

A DOT AT THE REFERENCE LINE BREAK INDICATES THAT THE WELD IS TO BE MADE AWAY FROM THE SHOP OR "ON LOCATION."

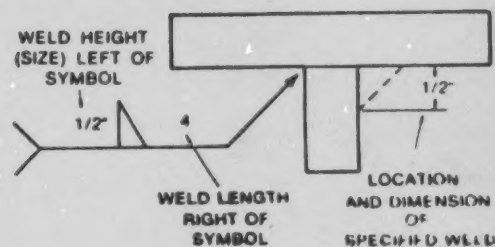


A 5/16" FILLET WELD SYMBOL INDICATED BY A BLUEPRINT

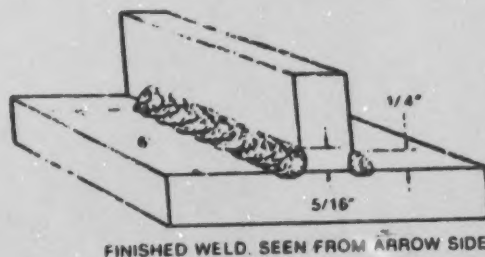
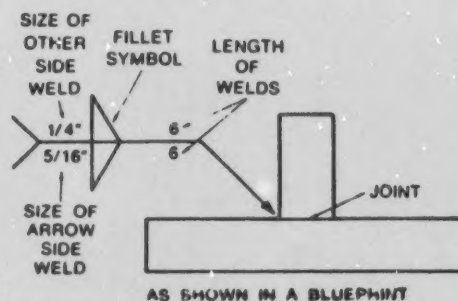


B TEE JOINT WELDED AS INDICATED BY THE BLUEPRINT

THE WIDTH OF THE WELD WILL APPEAR ON THE LEFT OF THE WELD SYMBOL.

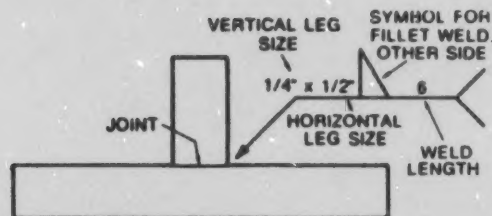


WELD DIMENSIONS MAY APPEAR ON A WELD SYMBOL.

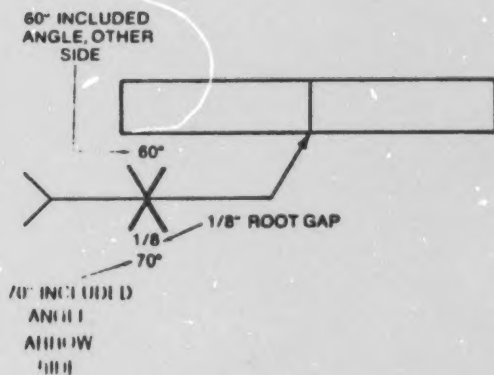


THE LENGTH OF THE WELD WILL APPEAR ON THE RIGHT OF THE WELD SYMBOL.

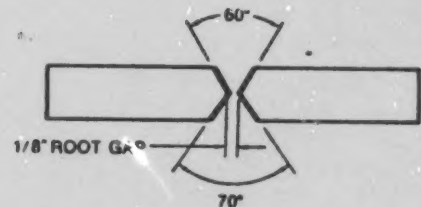
WELDING SYMBOLS



IF THE FILLET WELD IS TO BE THICKER ON ONE OF TWO MEMBERS OF THE TEE JOINT, THE WELD SYMBOL WILL HAVE THE VERTICAL LEG SIZE FIRST, FOLLOWED BY THE HORIZONTAL LEG SIZE.



A. AS SHOWN ON THE BLUEPRINT

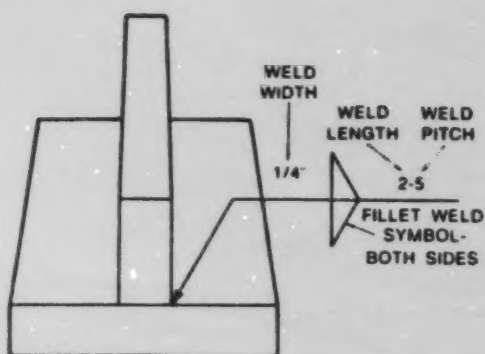


B. AS PREPARED AT THE JOINT

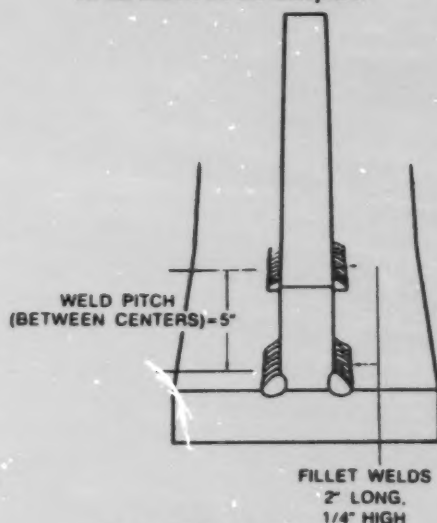
THE INCLUDED ANGLE SIZE, IN DEGREES, MAY BE PLACED IN THE VEE AS SHOWN. IF A ROOT GAP IS SPECIFIED, IT MAY ALSO BE PLACED IN THE VEE.

TRANSPARENCY I-5-J

WELDING SYMBOLS

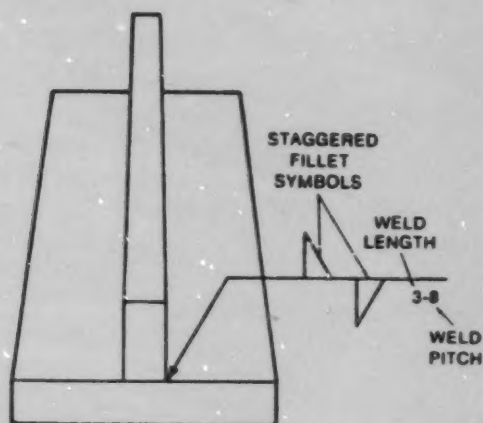


A. As shown on the blueprint.

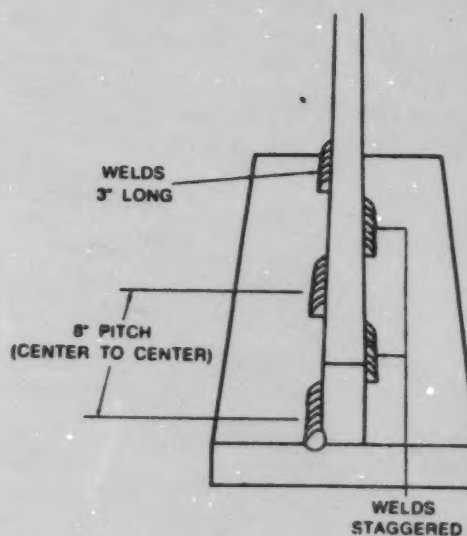


B. As welded at the joint.

IF A SECOND NUMBER IS GIVEN AFTER THE WELD LENGTH, IT IS THE WELD PITCH, THE DISTANCES BETWEEN THE CENTERS OF SEVERAL WELDS.



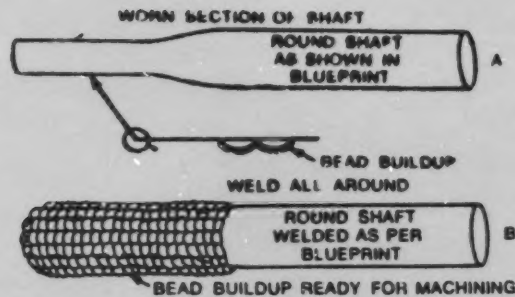
A. AS SHOWN ON THE BLUEPRINT



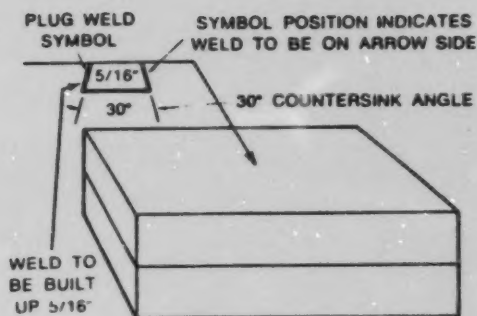
B. AS WELDED AT THE JOINT

IF THE WELD SYMBOLS ARE STAGGERED ON EITHER SIDE OF THE WELD LINE, THE WELD SHOULD BE STAGGERED ON EITHER SIDE OF THE JOINT.

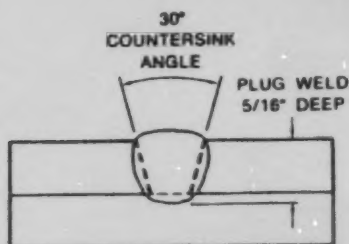
WELDING SYMBOLS



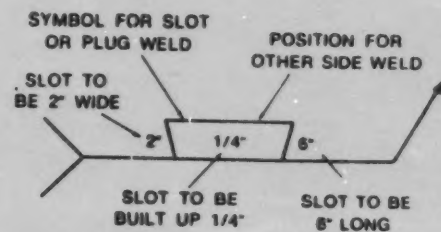
TWO HUMPS ON THE REFERENCE LINE TELLS THE WELDER TO BUILD UP THE AREAS WITH BEADS OR PADS.



A. As shown on the blueprint.



B. As prepared at the joint.



THE SLOT WELD SYMBOL IS SIMILAR TO THE PLUG WELD EXCEPT THAT IT ALSO HAS THE SLOTS LENGTH AND WIDTH INDICATED.

THE SYMBOL FOR A PLUG WELD WILL INDICATE THE PLUG WELD COUNTERSINK ANGLE, POSITION, AND HOW FAR THE PLUG IS TO BE BUILT UP.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT II: Oxy-acetylene Welding

LESSON 1: Safety

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the fundamental safety rules and procedures associated with oxy-acetylene welding.
2. Specific:
 - a. List and describe several safety rules pertaining to the areas listed below:
 - 1) Cylinders,
 - 2) Torches and regulators,
 - 3) Hoses,
 - 4) Setting up,
 - 5) Adjusting pressures,
 - 6) Operating the torch,
 - 7) Backfires and flashbacks, and
 - 8) Extinguishing the torch.

B. Review of Teaching Materials

1. Phipps, L. S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.
2. McCoy, V. L. and T. J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

Have on hand the safety equipment that is used in oxy-acetylene welding and cutting, such as cutting goggles, gloves, aprons, etc.

D. Materials Required

1. Overhead projector and screen
2. Materials listed above

II. Presentation of Lesson

A. Motivation

Safety cannot be "bought"; it must be "practiced." This is especially true when working with oxygen and acetylene gases. The most common hazards found in welding are burns caused by heated metal and welding dust, and injuries from toxic gases or fumes. The welder should be thoroughly informed regarding all safety practices, including the use of oxygen and acetylene for both welding and cutting.

B. Content Outline

1. Oxy-acetylene safety is of the utmost importance in welding and cutting because the welder is working with two flammable gases and an open flame. (Transparency II-1-A) For this reason, oxy-acetylene welding and cutting safety is broken down into the following eight categories:

a. Cylinders (Transparency II-1-B)

Cylinder safety includes:

- 1) Use only approved cylinders. Do not drop cylinders at any time.
- 2) Always call acetylene "acetylene"--not "gas." Call oxygen "oxygen"--not "air."
- 3) The approved method of determining what the contents of a cylinder contains is to look for a tag or markings on the cylinder near the valve. If it is unmarked, do not use it. Do not rely on color or size to distinguish between oxygen and acetylene.
- 4) Never use a cylinder for other than the cylinder's intended purposes.
- 5) Keep all oil and grease away from cylinders and especially the area around the cylinder's valve.
- 6) Do not store oxygen and fuel gas together; store separately.
- 7) Keep cylinders away from exposure to sparks, hot molten metal, an open flame, and any sources of excessive heat.
- 8) Never strike an arc on the cylinder or expose the cylinder to an electrical current.
- 9) Always make sure the cylinders are upright and secured to the wall or properly secured in a portable welding cart.
- 10) Always transport and store acetylene in the upright position.
- 11) Never try to lift the cylinder by the cap, with a sling, or by electric magnets.
- 12) Never try to refill a cylinder.

- 13) Mark all empty cylinders "Empty" or "MT."
 - 14) Never try to alter a cylinder.
 - 15) If the cylinder's valve does not open by hand, never take a wrench or hammer to force it open.
 - 16) If a leak is detected around the cylinder's valve or the cylinder's fuse plug and will not stop when the valve is closed, proceed as follows:
 - a) Take the cylinder out of doors, away from any possibility of being ignited.
 - b) Mark or tag the cylinder to show that it is dangerous and inoperable.
 - c) Notify the supplier as soon as possible.
 - 17) Always keep the caps to the cylinders on at all times when the cylinders are not being used.
 - 18) Never use anything but an approved wrench for the cylinder if the cylinder does not have a wheel type of valve on it. These wrenches can be obtained from the supplier.
- b. Torches and regulators (Transparencies II-1-C, D, and E)

Torch and regulator safety includes the following:

- 1) Never work with defective equipment. Leaking or damaged equipment can be explosive and should be repaired only by trained personnel.
- 2) Keep the torches and regulators clean and in operable condition at all times.
- 3) Keep all oil and grease away from torches or regulators. This includes oily rags or gloves that may have oil or grease on them.
- 4) Never connect a regulator to a cylinder it is not designed to operate from. Oxygen cylinders have right-handed threads and require that the oxygen regulator also have right-handed threads. The acetylene cylinder has left-handed threads and requires that the acetylene regulator also have left-handed threads. Never try to force the regulator onto a cylinder.

- 5) The regulators should be checked periodically to ensure that the gauges are reading accurately.
- 6) The torch is never to be used in place of a hammer to knock off a hot piece of metal after it has been cut. This can cause damage to the internal workings of the torch.
- 7) When the torch becomes clogged or stopped up, use only an approved tip cleaner and follow the proper procedure.
- 8) All connections to the torch and regulator should be made using an approved wrench. Some connections are only required to be hand tight. Check with the manufacturer.

c. Hoses

Hose safety includes the following:

- 1) New hoses contain talcum powder and must be blown out before the hose can be safely used.
- 2) Use only the hoses that are designed to be used with the welding system. Check with the supplier or manufacturer.
- 3) Most hoses are color coordinated--oxygen hoses are generally green while acetylene hoses are usually red. A groove in the nut on the end of the hose generally indicates that it is a left-handed thread.
- 4) Try to avoid excessively long hoses. They tend to kink that can lead to a dangerous situation because of mistreatment.
- 5) If a hose is burned, replace the hose. Use only approved splices and connectors. Check with the supplier.
- 6) Visually inspect the hoses every time they are used.
- 7) Check for leaks by immersing the hoses in water under normal working pressures.
- 8) Do not use tape to repair hoses.

d. Setting up (Transparency II-1-F)

Setting up safety includes the following:

- 1) Make sure the cylinders are placed in a secure, clean working area.
- 2) Always make sure that gloves and clothing are free from oil or petroleum products.
- 3) Always "purge" the cylinders before connecting the regulators. This is done by opening the valve on the cylinder and quickly closing it. Make sure that the valve opening is not pointing at any one. Purging the cylinder will blow out any foreign material that may have collected between the valve seat and the valve opening.
- 4) Never crack an acetylene valve around an open flame, sparks, or where a welder is working.
- 5) Always stand to one side of the regulator when opening the cylinder valve.
- 6) Always open the cylinder valves very slowly. On the oxygen cylinder, crack the valve slightly to allow the high pressure gauge pointer to slowly move to the maximum reading. Once the pressure has stabilized, fully open the oxygen cylinder valve. Never open the acetylene cylinder valve more than 1 1/2 turns--preferably less than 1 turn. The acetylene cylinder valve is a double seating valve, therefore, it does not need to be open fully.
- 7) If a special wrench is required to open the acetylene valve, leave it on the cylinder valve. In case of an emergency, it will allow quick closure of the valve.
- 8) Never try to find a leak with a flame--use soapy water (one part Ivory soap, which does not contain oils, with 4 to 6 parts water) or an approved leak-detector solution.

e. Adjusting Pressures

Pressure safety includes:

- 1) Always use manufacturer's charts as a guide to correct pressure for the job.

- 2) Never exceed an acetylene working pressure of 15 psig (gauge pressure). Acetylene is extremely unstable above this pressure setting and can explode.
- 3) Adjust oxygen pressure by first making sure that the acetylene valve on the torch is closed. Open the oxygen valve on the torch, adjust the regulator until the low pressure gauge indicates the proper working pressure. Once this is reached, close the oxygen valve on the torch.
- 4) Adjust the acetylene pressure by making sure that the oxygen valve on the torch is closed, and follow the same procedure as described above.

f. Operating the Torch

Operating the torch safely includes the following:

- 1) Always purge both the oxygen and acetylene gases before attempting to light the torch.
- 2) Always use a striker or friction lighter to light the torch. Never use matches or other means to light the torch. (Transparency II-1-C)
- 3) Make sure the work area is well ventilated before attempting to light the torch.
- 4) Never direct the gas stream (before lighting the torch) toward any clothing the welder may have on or toward any area that may entrap and hold gases.

g. Backfires and Flashbacks

A backfire is a sudden loud noise coming from the torch; the flame suddenly goes out and may be re-ignited. Some causes of a backfire are as follows:

- 1) Touching the tip of the torch against the work,
- 2) Clogged or dirty tip on the torch, and
- 3) The tip and/or the torch becoming overheated.

The procedure to follow after a backfire occurs:

- 1) In some cases, the trouble will clear itself and is correct to resume the normal procedure.
- 2) If the trouble has not cleared, immediately close the acetylene valve on the torch. Close the oxygen valve on the torch. If a cutting attachment is being used proceed as follows:
 - a) Cut acetylene valve off on the torch first,
 - b) Then cut the oxygen cutting valve on the torch off, and
 - c) Finally, cut the oxygen preheat valve off on the torch.

Check for obstructions. Check for correct pressures. Purge the lines and re-light the torch.

A flashback is an actual fire or burning back of the flame into the tip, torch, or in some cases the hoses. Indications of a flashback:

- 1) The torch making a squealing or hissing noise,
- 2) Smoke coming from the tip of the torch,
- 3) A sharp-pointed flame,
- 4) Incorrect oxygen and acetylene pressures,
- 5) Loose or distorted tips or mixing seats, and
- 6) An overheated tip or torch body.

The procedure to following if a flashback occurs:

- 1) Immediately close the acetylene valve on the torch, and
- 2) Close the oxygen valve on the torch. If the situation is severe enough that the fire is detected in the hoses--immediately close the acetylene cylinder valve and clear the shop of all personnel.

In most cases, the situation is not dangerous as the one mentioned above. If no fire is evident after both valves have been closed, wait a few minutes, which should give enough time for the flame inside of the torch to burn itself out.

A flashback is an indication that something is drastically wrong with the system. Before attempting to relight the torch make sure the procedure given below is followed:

- a) Purge the lines individually,
- b) Check to ensure the pressure settings are correct, and
- c) Remove the hoses to inspect for any internal damage. If the flame caused any damage to the hose, cut back to the undamaged portion of the hose and remake the connections (following approved practices).

h. Extinguishing the Torch

Safety in extinguishing the torch:

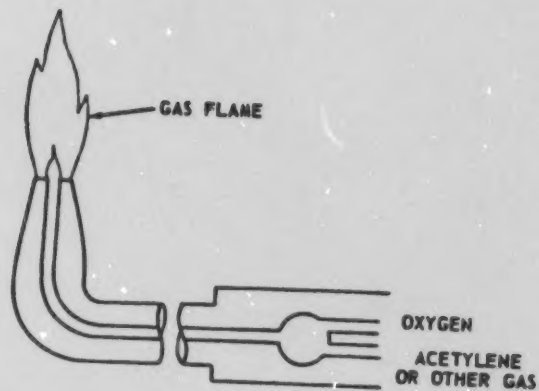
- 1) Always close the acetylene valve on the torch first--this will extinguish the flames. Make sure that the flame is completely extinguished. Close the oxygen pre-heat valve (or the oxygen valve on the torch body if torch is set up for welding instead of cutting) to stop all flow of gases coming through the torch.
- 2) If the torch is to be shut down for a brief interval, step 1 will suffice.
- 3) Never hang the torch or hose onto a regulator or a cylinder unless the system has been drained of all gases.
- 4) When the work is completed or discontinued for the day, proceed as follows to secure the system:
 - a) Close both cylinder valves.
 - b) Drain all oxygen from the system by opening the torch oxygen valve.
 - c) Make sure that both the high pressure and low pressure gauges go to zero on the oxygen cylinder; then close the torch oxygen valve.
 - d) Drain all acetylene from the system by opening the torch acetylene valve.

- e) Make sure that both the high pressure and low pressure gauges go to zero on the acetylene cylinder, then close the torch acetylene valve.
- f) Release the regulator pressure adjusting screw on both regulators.
- g) Roll up the hoses and secure them in the proper manner. Secure the torch in the proper manner, making sure that a hot torch does not come into contact with either the hoses or the cylinders.

C. Suggested Student Activities

After a demonstration in the safety procedures has been given to the students, assign them to demonstrate their ability to follow all safety rules in setting up the torch, lighting, extinguishing, and securing the system.

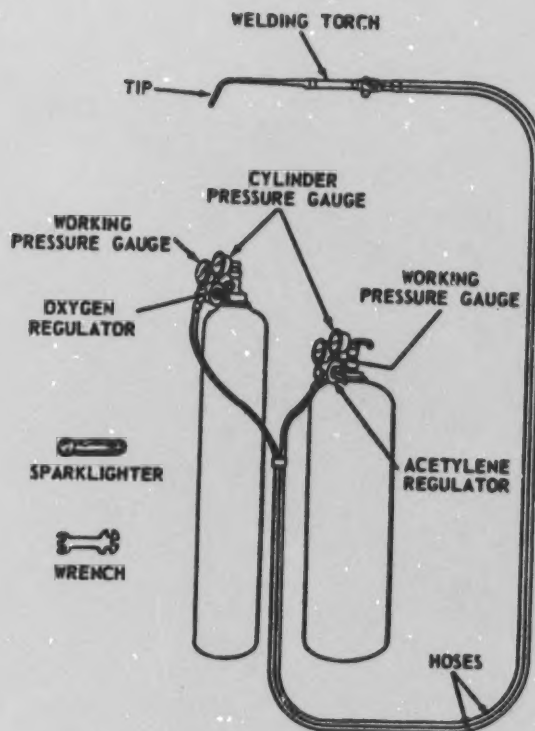
OXY-ACETYLENE SAFETY



Welder is working with two flammable gases and on open flame.

TRANSPARENCY II-1-A

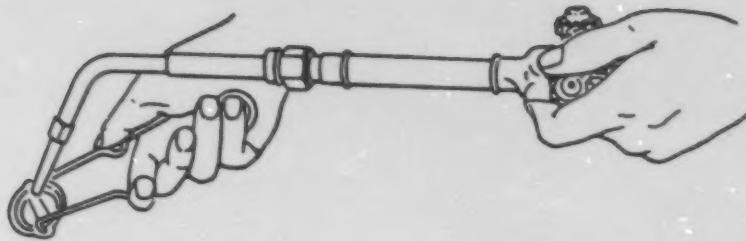
OXY-ACETYLENE SAFETY



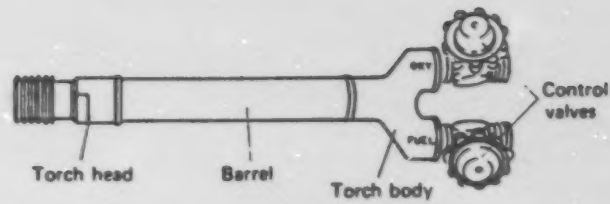
Parts of the oxy-acetylene system that require a thorough knowledge of safety practices. Cylinders, torch and regulators, and hoses.

TRANSPARENCY II-1-B

TORCH SAFETY



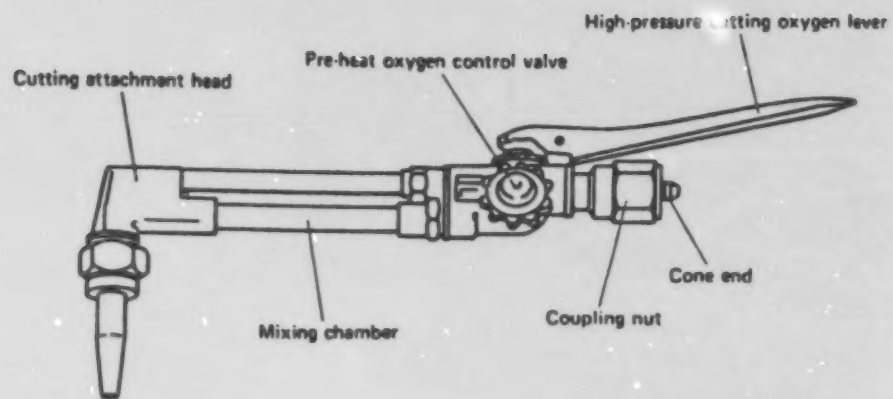
Always use a sparklighter when lighting the torch.



Parts of a common torch.

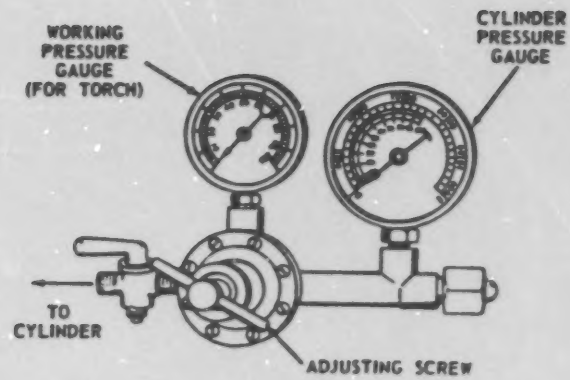
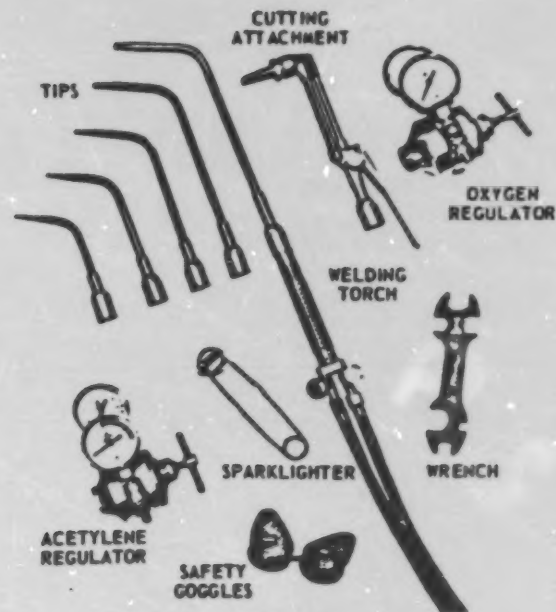
TRANSPARENCY II-1-C

TORCH SAFETY



PARTS OF AN OXY-ACETYLENE CUTTING ATTACHMENT.

REGULATOR SAFETY



TRANSPARENCY II-1-E

FIVE BASIC RULES OF OXY-ACETYLENE WELDING AND CUTTING



1. Keep oxy-acetylene equipment clean, free of oil, and in good condition.



2. Avoid oxygen and acetylene leaks.



3. Open oxygen valves slowly.



4. Purge oxygen and acetylene lines before lighting torch.



5. Keep heat, flame, and sparks away from combustibles.

TRANSPARENCY II-1-F

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT II: Oxy-acetylene Welding

LESSON 2: Set-up and Techniques of

- (a) Welding,
- (b) Cutting, and
- (c) Brazing.

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Demonstrate the safe and proper techniques for setting up and operating the oxy-acetylene torch for welding, cutting, and brazing.
2. Specific:
 - a. Define each of the following terms:
 - 1) Oxy-acetylene welding,
 - 2) Oxy-acetylene cutting, and
 - 3) Brazing.
 - b. List the equipment necessary for oxy-acetylene welding.
 - c. Demonstrate the proper procedure for each of the following:
 - 1) Cylinder(s) set-up,
 - 2) Regulator(s) set-up,
 - 3) Setting up and lighting the torch, and
 - 4) Torch operation for
 - a) Welding,
 - b) Cutting, and
 - c) Brazing.

- d. Name and describe the three types of flames associated with oxy-acetylene welding.
- e. Differentiate between forehand and backhand welding.
- f. List the different classifications of metals that can be cut with the oxy-acetylene torch.
- g. Explain the proper procedure for piercing holes in metal with the oxy-acetylene torch.
- h. State the most important factor in brazing (advantage).
- i. Explain the requirements for brazing.
- j. Define the term flux.
- k. Name the three common commercial forms of flux.
- l. State several requirements for filler metal used in brazing.

B. Review of Teaching Materials

- 1. McCoy, V. L. and T. J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.
- 2. Phipps, L. S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

C. Special Arrangements

Have on hand an assortment of oxy-acetylene equipment, tools, and supplies.

D. Materials Required

- 1. Overhead projector and screen
- 2. Materials listed above

II. Presentation of Lesson

A. Motivation

- 1. A welder should have knowledge of the gases used for welding and cutting. The welder should also be acquainted with safety procedures and the proper techniques in gas welding and cutting.

In all flame cutting, welding, and heating, oxygen and a fuel gas (acetylene, most commonly used) are combined

and burned to provide heat to do a certain type of job. The welder must be able to use these combined heating gases effectively to turn out high-speed, economically finished jobs of high quality.

2. Oxy-acetylene cutting is fast and efficient, compared with alternatives like a hacksaw, cold chisel, and hammer, etc.
3. Recent research on oxy-acetylene welding indicates that this process may be phased-out by the year 2000. The use of oxy-acetylene cutting procedures will be dominant for many more decades however.

B. Content Outline

Gas welding is a process by which two pieces of metal are joined together by melting or fusing their adjoining surfaces or edges. Gas welding is slower than electric arc welding, but it has the advantage of being easier to control.

The two most common gases used in gas welding are oxygen and acetylene. A ratio of $2\frac{1}{2}$ parts oxygen to 1 part acetylene produces a very hot flame of approximately 5800°F.

The following equipment is necessary for oxy-acetylene welding:

1. A cylinder of oxygen and a cylinder of acetylene,
2. Pressure regulators,
3. Welding torch,
4. Hoses,
5. Welder's protective clothing,
6. Welder's goggles, and
7. Miscellaneous equipment.

Below is a brief description of the items listed above:

1. Size of cylinders is determined by the cubic feet of gas the cylinder will hold. Acetylene cylinders are commonly found to hold 300, 100, and 60 cu. ft., whereas oxygen cylinders normally come in sizes of 244, 122, and 80 cu. ft.

Both oxygen and acetylene are stored in specially built cylinders made from seamless drawn steel and tested rigorously.

The acetylene cylinder is packed with a porous material saturated with acetone. This is done because the free acetylene cannot be stored in cylinders over 30 psi. Over 30 psi acetylene is a very unstable gas and can readily explode. Acetylene should never be used beyond 15 psi.

2. Both oxygen and acetylene regulators have two gauges-- a high pressure gauge that indicates the pressure inside of the cylinder and a low pressure gauge that

indicates the pressure on the hose. The amount of pressure on the hose is determined by the adjusting screw found on the regulator.

3. The welding torch includes the body of the torch, (mixing chamber where the two gases are brought together and mixed) two needle control valves to control the flow of oxygen and acetylene, two hose connections, and a welding tip.
4. Special nonporous hoses are used to convey oxygen and acetylene from the cylinders to the torch. The hoses are color coordinated (red indicating acetylene and green or black for oxygen). The oxygen hose connectors have right-handed threads, while the acetylene hose connectors are left-handed.
5. The welder at all times must wear protective cutting goggles when oxy-acetylene welding. Fire-resistant gloves should also be worn during this procedure.
6. A fire extinguisher should be in the working area at all times. Other equipment needed:
 - a) Wire brushes,
 - b) Friction lighter,
 - c) Soap stone or a means of marking the metal, and
 - d) Square (try, combination, or framing).

When setting up the cylinders for oxy-acetylene welding, follow these steps:

1. Place both the oxygen and acetylene cylinders together and secure them to keep from falling. They may be chained along the wall or chained in a portable welding cart. (Transparency II-2-A)
2. Remove the cylinder valve caps. Place in a location so that they will be accessible.
3. Visually examine the cylinder valve. If it appears the threads are in good shape and there are no obstructions, crack the valve slightly to blow out any dirt or dust and quickly close.

When setting up the regulators proceed as follows:
(Transparency II-2-B)

1. Be sure that the regulator inlet connections are free from any obstruction, dirt, dust, and/or grease.

2. Attach the oxygen regulator to the oxygen cylinder by using an open-end wrench or an oxy-acetylene wrench (check with the supplier). The regulator should be tightened snugly, but not with excessive force.
3. Make sure the adjusting screw is "backed-out." This will relieve all tension on the regulator. The adjusting screw is turned counterclockwise to relieve tension.
4. Connect the hoses to the regulator outlet that is provided. The green or black hose is connected to the oxygen regulator (right-handed threads) and the red hose is connected to the acetylene regulator (left-handed threads).
5. Open the oxygen cylinder valve very slowly. Watch the high pressure gauge, and when it reaches the maximum reading open the cylinder valve all the way. Never stand or allow anyone to stand in front or back of the regulator during this procedure.
6. Adjust the adjusting screw to the desired pressure reading, which is shown on the low pressure gauge.
7. The acetylene cylinder is attached following the steps described above with the following exception:

The acetylene cylinder valve is opened slowly to allow the pressure to slowly build on the high pressure gauge until this pressure has reached its maximum.

The procedure for setting up the torch is described below:

1. Connect the green hose to the valve on the torch body marked "oxy" and the red hose to the valve on the torch body marked "fuel." The oxygen connection will be a right-handed connection while the acetylene connection will be a left-handed connection. Tighten the connection snugly with an open-end wrench or an oxy-acetylene wrench.
2. Select the welding tip that will be used and place it in the connection provided on the torch body. Tighten the welding tip only hand tight unless the manufacturer specifies differently.
3. Open the oxygen valve on the torch body and adjust the adjusting screw on the regulator until the desired pressure is reached. Close the oxygen valve on the torch body.

4. Open the acetylene valve on the torch body and adjust the adjusting screw on the regulator until the desired pressure is reached. Close the acetylene valve on the torch body.

For torch operation, follow the listed guidelines:

1. Hold the friction lighter in one hand and the torch in the other. Make sure all safety equipment, including protective clothing, is being used.
2. "Crack" (open approximately $\frac{1}{2}$ turn) the acetylene valve on the torch body and immediately strike the friction lighter to establish a flame from the torch. Make sure the flame is pointed away from any combustible materials or people.
3. Once the flame is established, open the acetylene valve on the torch to get rid of the black carbon smoke. Open until the flame actually leaves the tip approximately $\frac{1}{8}$ of an inch, then close the valve on the torch slightly until the flame returns to the tip.
4. Slowly open the oxygen valve on the torch body until a neutral flame is reached (Transparency II-2-C). There are three types of flame associated with oxy-acetylene welding. They are described below:
 - a. Neutral flame: consists of equal parts of oxygen and acetylene. It is the most commonly used flame for gas welding. The inner portion has a blunt end and a temperature of approximately 5600°F. The larger portion of the flame is generally blue in color. The neutral flame consumes all the oxygen in the air around the area to be welded, which prevents oxygen from being mixed with the hot molten metal which weakens the weld.
 - b. Oxidizing flame: a flame that is obtained whenever there is more oxygen than acetylene. This type of flame is rarely used in fusion welding, although it is used in braze welding. The inner cone is pointed rather than being blunt as in a neutral flame. The oxidizing flame is the hottest of the three types of flame and reaches temperatures of about 6000°F.
 - c. Carburizing flame: a flame that is obtained whenever there is more acetylene than oxygen. The carburizing (sometimes referred to as a "reducing flame") flame has a blunt inner cone. Flame color is yellowish to orange.

For procedure on how to weld, follow the steps below:
(Transparencies II-2-D and E)

1. The welding torch can be operated in two ways:
 - a. Forehand welding: the torch is pointed forward in the direction of travel in which the weld and filler rod (if used) precedes the flame.

The forehand welding method is best for metals that are 1/8 of an inch and less in thickness. This allows for a better weld puddle and smoother welds.
 - b. Backhand welding: the tip is pointed backwards from the direction of the weld, which has been deposited (and the filler rod if used) between the flame and the weld. This technique is usually recommended for metals that are heavier than 1/8 of an inch because sound welds can be made with greater speed.
2. The torch is always held at a 45° angle to the completed weld. In the forehand method, usually the circular or semi-circular (also known as the "horse shoe") weaving pattern is used.
3. The inner cone of the oxy-acetylene welding flame should be held between 1/8 to 1/16 of an inch from the base metal.
4. When the flame actually melts the metal (or starts to burn through a thin piece of metal) a puddle is formed. This is hot molten metal in a liquid form. It takes practice to keep the puddle formed and going in the direction on the weld. Keep the puddle small.
5. Some oxy-acetylene welding techniques require the use of a filler rod. A filler rod is of the same composition as the base metal and is used for welding most types of joints. The diameter of the rod should be equal to the thickness of the base metal. The rod is held at the same angle as the torch but slanted away from the torch.

As the puddle is carried forward, the rod is dipped in and out of the puddle. The rod should never be taken far from the flame of the oxy-acetylene welding torch, it should be kept inside of the outer envelope on the flame. Hints for using a filler rod:

- a. Hold the rod in the puddle, away from the edges,
and

- b. Concentrate the flame in the puddle and around the rod to preheat the plates ahead of the weld.

A good weld will have a slightly convex shape, being even and uniform, and just penetrates the complete joint as shown in Transparency II-2-F.

6. When the welding is finished or to be stopped, always turn the acetylene valve on the torch off first. Next close the oxygen valve on the torch, this should stop all flow of gas from the tip.

When welding is to be discontinued for a considerable period of time (such as lunch or overnight), the cylinder valves should be closed and the gas released from the system as described under "Extinguishing the Torch" in the lesson entitled "Oxy-acetylene Safety."

Oxygen Cutting: metal is heated by a gas flame in which oxygen jets are used to do the cutting. The most commonly used fuel gas is acetylene, which is used to heat the metal to its melting point, and the oxygen is used to blow or burn through. The oxygen cutting torch is the apparatus used to accomplish this cutting procedure. The following metal can be cut using the oxygen cutting torch:

1. Plain carbon steels,
2. Low-alloy steels,
3. Manganese steels, and
4. Low-content chromium steels.

Nonferrous metals and stainless steels cannot be cut the oxygen cutting torch.

The procedure to follow in using the oxygen cutting torch is described below:

1. Before starting to cut, observe all safety rules as described in the lesson entitled "Safety" for oxy-acetylene welding.
2. Attach the cutting attachment to the body of the torch and tighten the fittings hand tight.

A different type of torch (blowpipe and tip) is used for cutting metal than for welding. The cutting tip has 3 to 8 holes located around the center hole. These small orifices furnish flames to preheat the metal, and the center orifice furnishes oxygen to cut the metal. (Transparency II-2-G)

An oxy-acetylene cutting torch has three controls. They are preheat oxygen valve, preheat acetylene valve, and a cutting oxygen valve that is controlled by a lever. The two preheat valves actually furnish heat on the surface to a kindling temperature of the steel being cut, and the cutting oxygen controlled by the lever ignites the molten metal and blows it from the heated area.

Lighting and adjusting the blowpipe are very important steps when cutting metal. If the manufacturer's instructions are not available, proceed as follows:

1. Hold the blowpipe with the tip pointing away from the body. Open the acetylene valve about 1/2 turn and light the torch with the friction lighter. The flame should clear the tip end about 1/8 inch when first lit, but it should be adjusted back to the tip.
2. Adjust the regulator pressure by turning the adjusting screws clockwise. Oxygen pressure depends on the thickness of the metal being cut, usually approximately 25 psi will suffice although a 1" thick piece of metal requires about 30 psi. Acetylene pressure will vary from 3 to 10 psi (usually around 7 psi will suffice), but under no circumstances should it exceed 10 psi.
3. Adjust the preheat oxygen valve until a neutral flame appears with sharp inner cone, then press the cutting oxygen lever and readjust the flame by turning the preheat oxygen valve while the cutting lever is in the downward position. This readjustment is to correct the flame from carburizing to neutral when the lever is not depressed.

The metal to be cut should be clean, marked with a punch or soapstone, and placed in a suitable position for cutting. The position can also involve the location of cutting. Be sure to remember that hot metal will damage the welding unit hoses and may even cause a fire.

The cutting tip is held at 45° angle to start the cut and is raised to about 75° to make the cut. The steps to follow in making a cut are as follows: (Transparency II-2-H)

1. Hold the blowpipe perpendicular to the surface of the metal unless bevels are to be cut. Place flame inner cone within 1/16 to 1/8 inch above the plate or metal surface. Metal will not stick on the tip if it is held at a proper distance from the surface. Hold the tip so that two preheating holes are in line with the oxygen hole.

2. Hold the torch at the edge of the metal until the metal begins to melt. The top of the torch may be slanted toward the cut and changed to a vertical position as the cut progresses.
3. Press down slowly on the oxygen cutting lever until the cutting valve is completely open. When the cut is through the metal, move the torch along the line.
4. Tilt the torch tip slightly toward the direction of cut on thin metal. It should be held vertical on thick metal when making a straight cut.
5. Move the torch slowly along the surface or the oxygen stream will not pass completely through the metal. The cut can be restarted by releasing the cutting lever and reheating the metal again before pressing the cutting lever. Irregular edges may be caused by losing the cut.
6. When beveling plate edges or cutting an angle, lean the tip at the desired angle and hold the torch parallel to the work.

Steps to follow when piercing holes in metal are as follows: (Transparency II-2-I)

1. Hold the blowpipe in the same position (tip perpendicular to the surface) until a spot on the surface begins to melt.
2. Raise the blowpipe (torch) until the end of the nozzle is about $\frac{3}{8}$ to $\frac{1}{2}$ inch above the surface and slowly press the cutting lever as the torch is raised.
3. Move the tip to one side of the heated area so that the slag (nonmetallic material in the heated metal) can be blown out.
4. Move the inner cone within about $\frac{1}{8}$ inch from the surface and make the cut on the inside edge of the hole.
5. To facilitate the cutting of a hole in thick metal, drill a hole $\frac{1}{4}$ inch or larger by using a twist drill and start the piercing in this hole.

Steps to observe when lighting the blowpipe:

1. Hold the torch in one hand and the friction lighter in the other. The welding goggles should be pulled from the forehead over the eyes.

2. Open the torch acetylene valve about 1/8 to 1/4 turn with the tip pointing away from the body and cylinder. The lighter should be held about an inch from the point of the tip while lighting the torch.
3. Open the acetylene valve until the flame stops smoking excessively and breaks away from the tip about 1/8 inch. The flame is then reduced slightly to bring it back to the tip. The valve is opened again very slightly. If there is a backfire, the flame will go out with a pop. Check the pressure, connections, and heated tip to correct this problem.
4. Open the oxygen valve slowly until a sharp inner cone appears, creating a neutral flame.

The correct procedure for turning off the oxy-acetylene cutting torch is listed below:

1. First the acetylene valve is closed on the torch and then the oxygen valve is closed. This assures the operator that the flame is out, thus reducing the possibility of a flash-back that can be caused by a carbon deposit in the tip.
2. The oxygen torch valve is the second valve to be closed. This procedure is followed by closing the acetylene and oxygen cylinder valves.
3. The acetylene and oxygen torch valves are opened to release hose pressure and then they are closed again. Be sure that the pressure regulator gauges go to zero, indicating no pressure on the hoses.
4. The acetylene and oxygen regulator adjusting screws are backed out until they are loose.

Brazing is a method that is used to join metals using filler metal that is melted between two closely fitting metal surfaces. The major difference between brazing and soldering is that in brazing the filler metal is melted at a higher temperature and fuses by capillary action, giving a stronger joint. For brazing most metals, a temperature of above 800° F is most often used, using a nonferrous filler metal that has a melting point below that of the base metal.

An important factor in brazing is that there is less danger of destroying the mechanical properties of the base metal since lower temperatures are used in this type of fusion process.

Requirements for brazing--The requirements for brazing are listed below:

1. The joints must have relatively small clearances and surfaces that are free of oxide and other contaminants.
2. Cleaning is done by a special flux that when heated is capable of dissolving all foreign matter. A flux can be defined as an aid used to prevent the formation of oxides (rust, tarnish, etc.) during the brazing process. The common commercial fluxes are...
 - a. Paste,
 - b. Liquid, or
 - c. Powder form.

Fluxes have as their main ingredients:

- a. Borates,
 - b. Fused borax,
 - c. Boric acid,
 - d. Fluorides,
 - e. Chlorides, and
 - f. Fluoroborates.
3. Filler metal should meet these requirements:
 - a. Enough fluidity so that the metal will flow evenly by capillary action.
 - b. Good melting to form a sound metal bond.
 - c. Melting point consistent with the type of metal to be joined.
 - d. Brazing filler metals fall into seven groups:
 - 1) Silver,
 - 2) Aluminum-silicon.
 - 3) Copper-phosphorus,
 - 4) Gold,
 - 5) Copper and copper-zinc,
 - 6) Magnesium, and
 - 7) Nickel.

Torch heating is probably the most commonly used method of brazing. Other forms of applying heat are furnace heating and induction heating.

Oxygen and acetylene are more versatile for torch brazing because of their wide range of heat controls. A slightly reducing flame is required and care must be taken to prevent the inner cone of the flame from coming in contact with the base metal. Close contact to the base metal may cause the base metal to melt, and that would be detrimental to the process. Remember that brazing is not a fusion process.

The recommended procedure to follow in brazing is given below:

1. Before getting started:
 - a. Make sure base metal is clean,
 - b. Closely align the parts, and
 - c. Heat the tip of the brass filler rod and dip into the flux. The flux will adhere to the rod.
2. Use a neutral or slightly oxidizing flame. Preheat the base metal to approximately 1500°F (a dull cherry red).

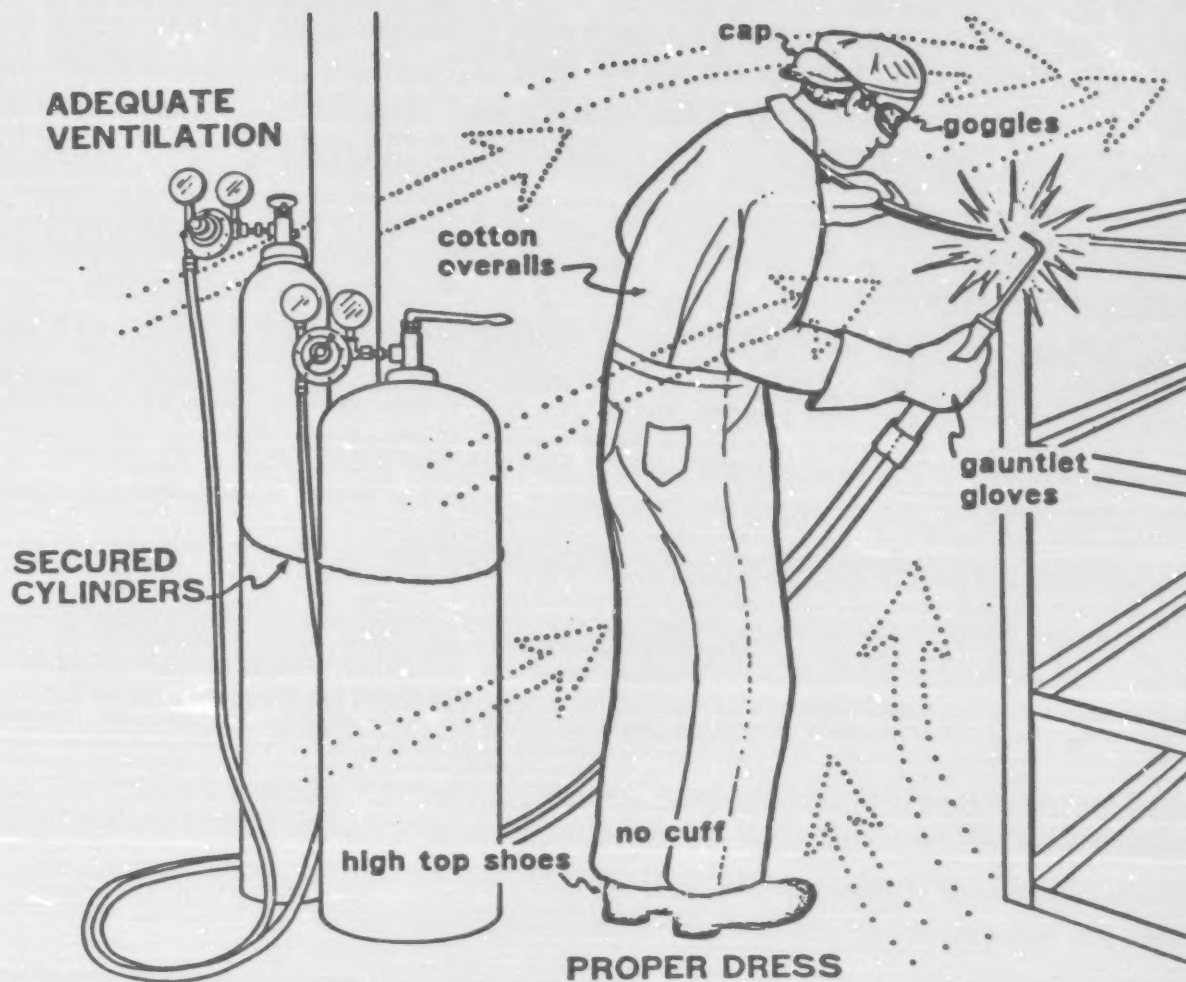
CAUTION: Do not overheat or the weld may become porous, and the process will be difficult to perform.
3. Touch the fluxed filler rod to the base metal and allow it to react with the base metal. This will aid in cleaning of the joint.
4. Melt a small amount of the fluxed rod until it flows freely to the tin joint. When this happens, the correct temperature of the base metal has been reached. If the filler metal forms beads on the base metal, this is an indication that the base metal is not hot enough. However, if the filler metal spreads or runs over a large area of the joint, this would be an indication that the base metal is too hot. To aid in keeping the base metal at the correct temperature once it is achieved, keep the flame's inner cone approximately 1/16 of an inch above the joint.
5. Continue to dip the filler rod into the flux before it is melted over the joint. The technique employed in this process is the same as the process that is used in oxy-acetylene gas welding with a filler rod.
6. After completing the joint, check it for:

- a. Color--if it is copper-colored with a white smoke and has a small valley down the center of the weld, the base metal was too hot.
- b. If the edge of the bead appears to lap over the base metal, then the base metal temperature was too cold.

C. Suggested Student Activities

Have students practice welding, cutting, and brazing. There are all types of shop exercises that can be used to acquire these skills. Check the reference section.

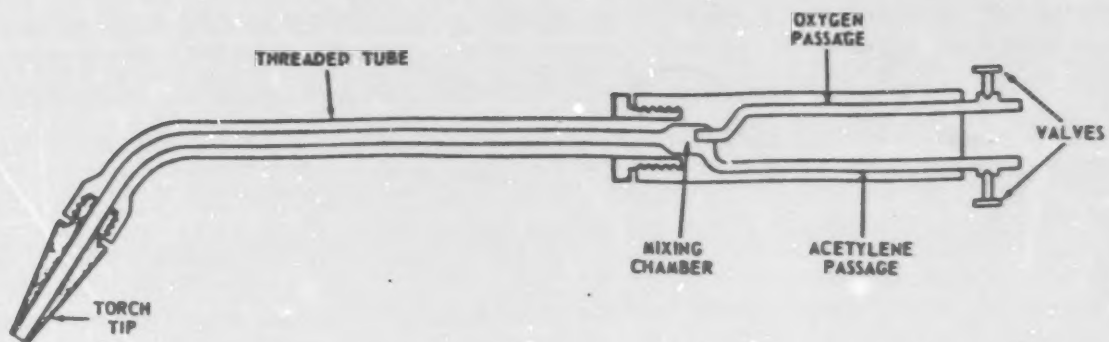
SAFETY FIRST



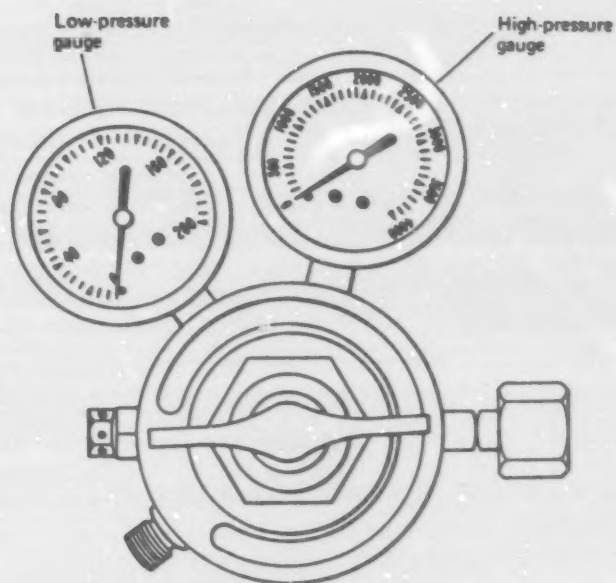
IMPORTANT SAFETY FEATURES ARE SHOWN ABOVE
WHILE OPERATING WITH OXYGEN AND ACETYLENE
GASES.

TRANSPARENCY II-2-A

PARTS OF AN OXY-ACETYLENE TORCH

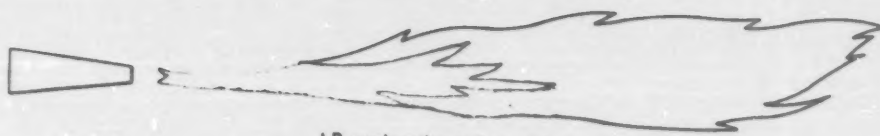


PARTS OF A REGULATOR



THE REGULATOR ABOVE IS FOR OXYGEN.

THREE TYPES OF OXY-ACETYLENE WELDING FLAMES



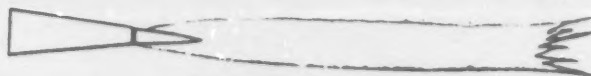
LP gas burning in atmosphere
(Open fuel gas valve until flame begins to leave tip end.)



Carburizing flame
(Excess LP-gas with oxygen, for heating and soft soldering or silver brazing.)

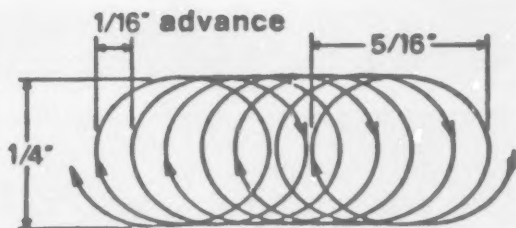
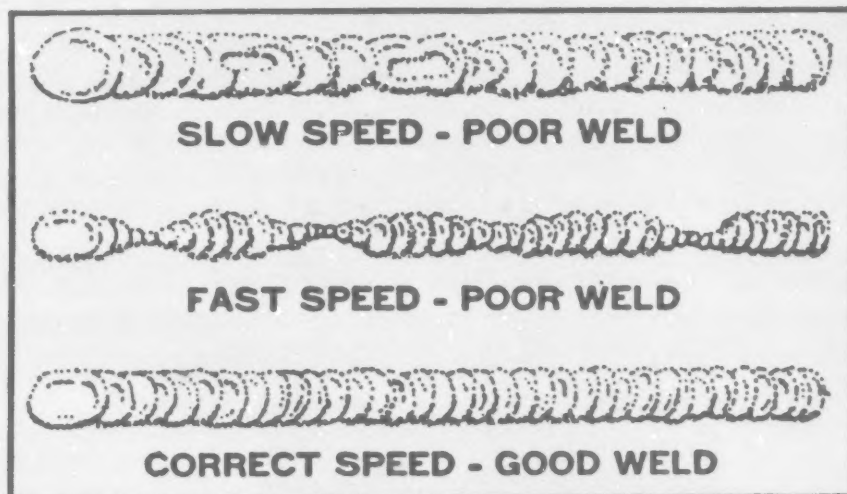
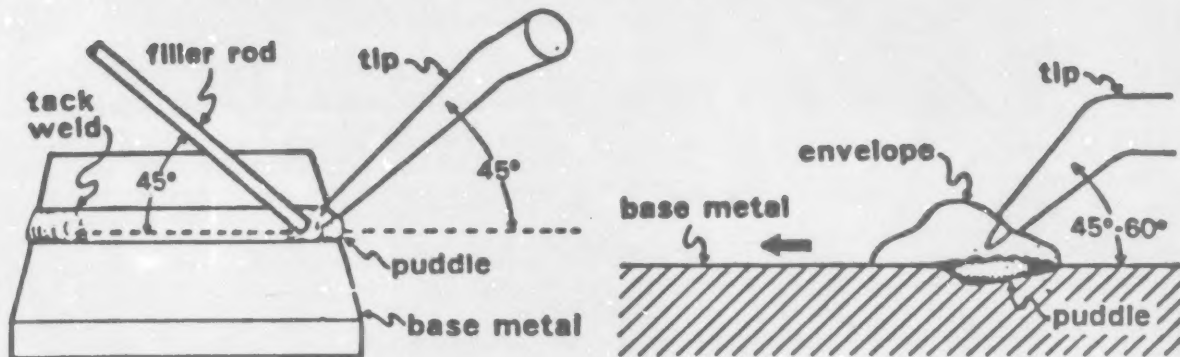


Neutral flame
(LP-gas with oxygen, for braze welding light material.)



Oxidizing flame
(LP-gas with excess oxygen, hottest flame about 5300° F (2927°C), for fusion welding and heavy braze welding.)

WELDING PROCEDURES

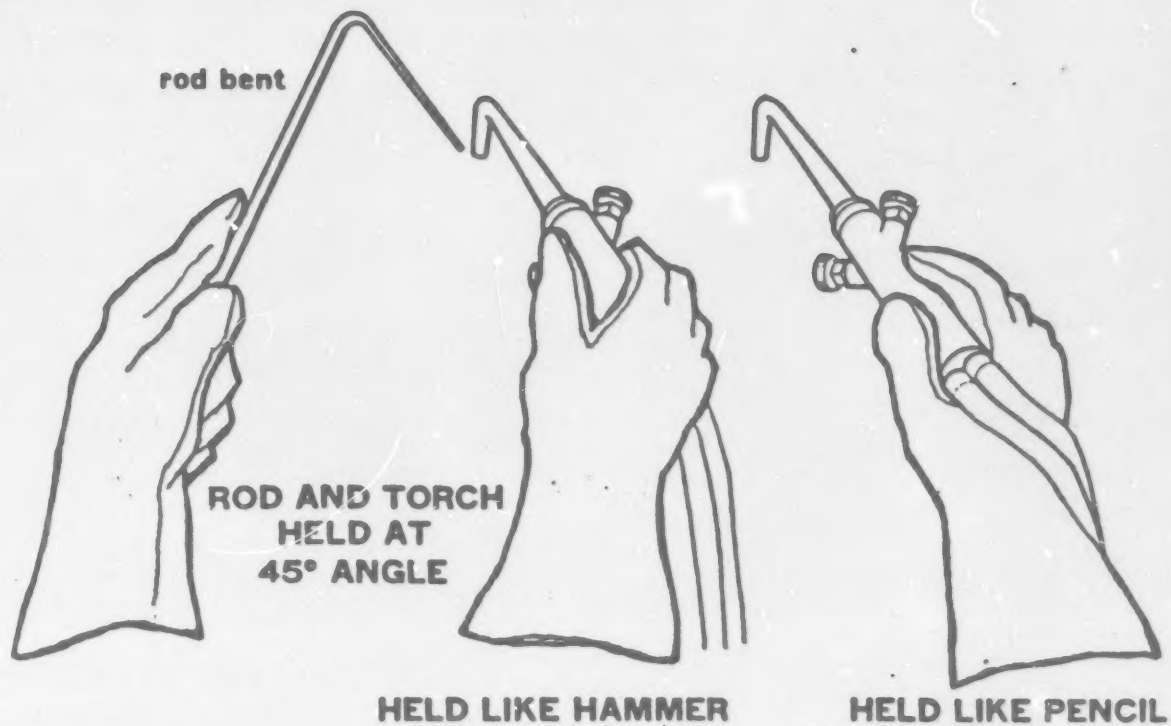


CIRCULAR MOTION

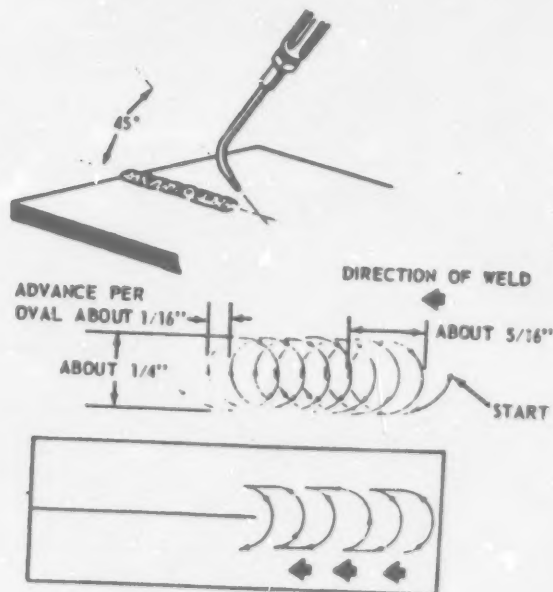


ZIGZAG MOTION

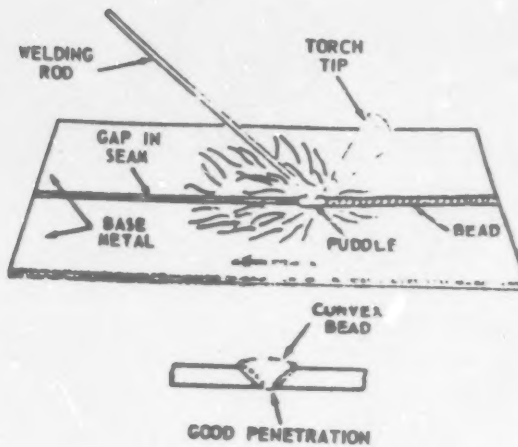
HOW TO HOLD THE BLOWPIPE



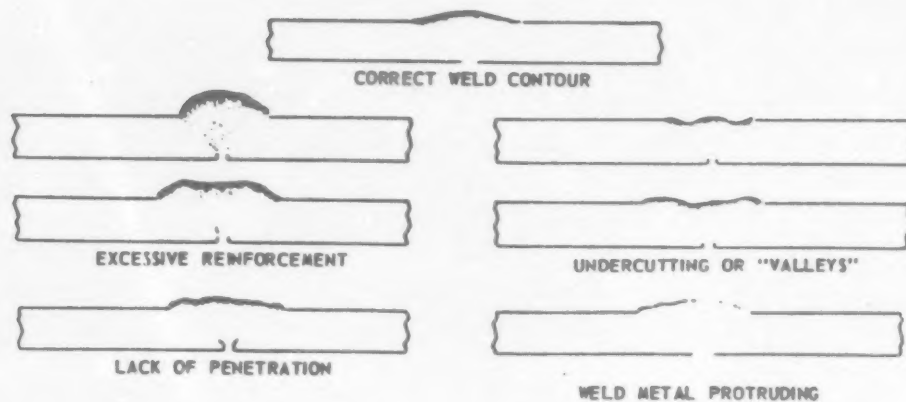
POSITION AND MOTION OF THE TORCH



POSITION OF THE FILLER ROD

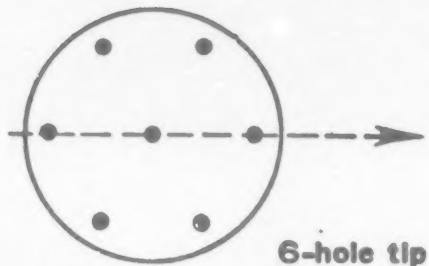
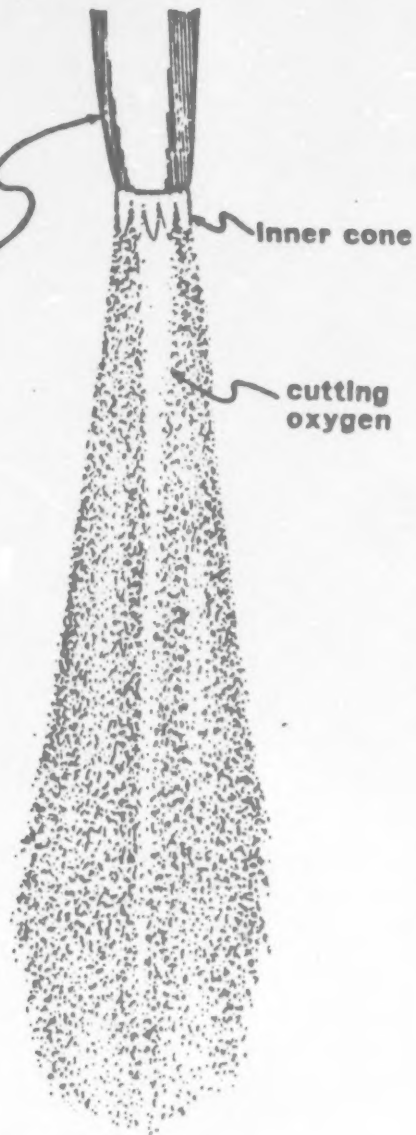
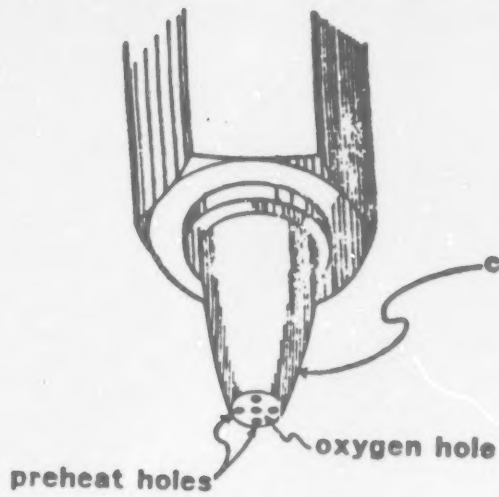


GOOD AND POOR WELDS



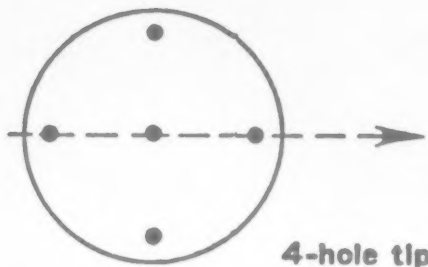
TRANSPARENCY II-2-F

OXYACETYLENE CUTTING



6-hole tip

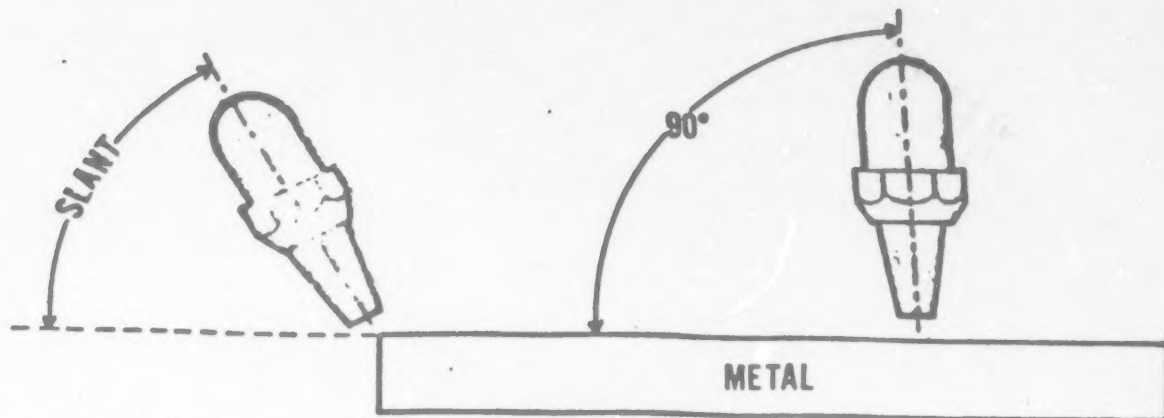
LINE OF CUT



4-hole tip

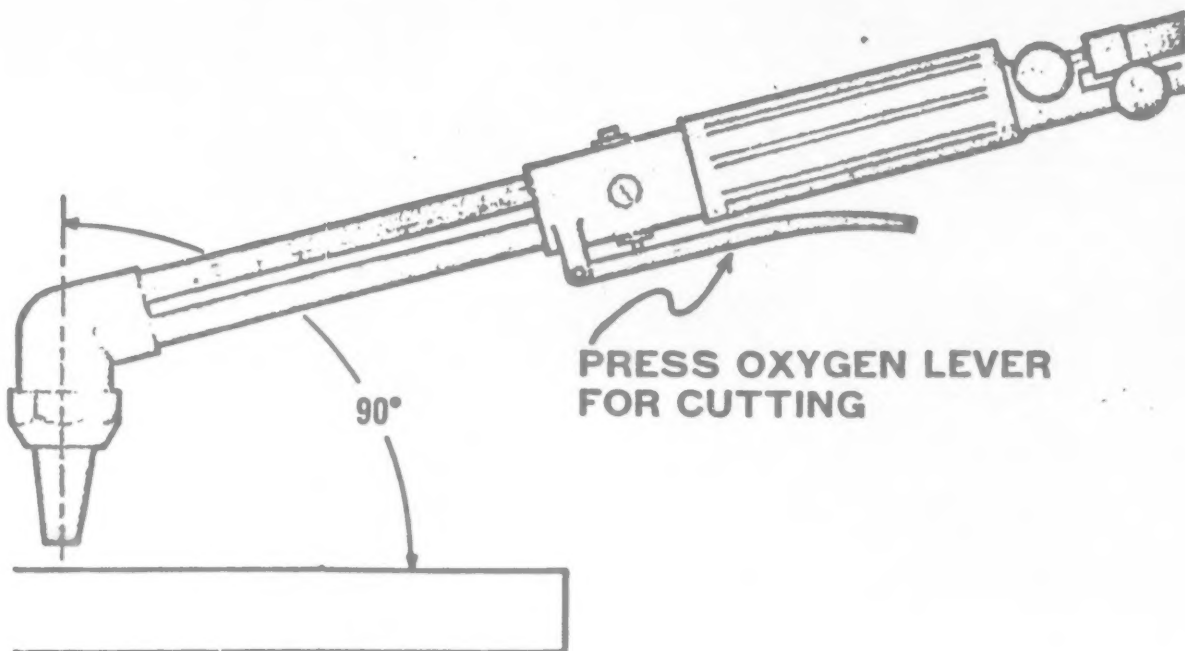
NEUTRAL FLAME
WITH
CUTTING JET OPEN

CUTTING METAL

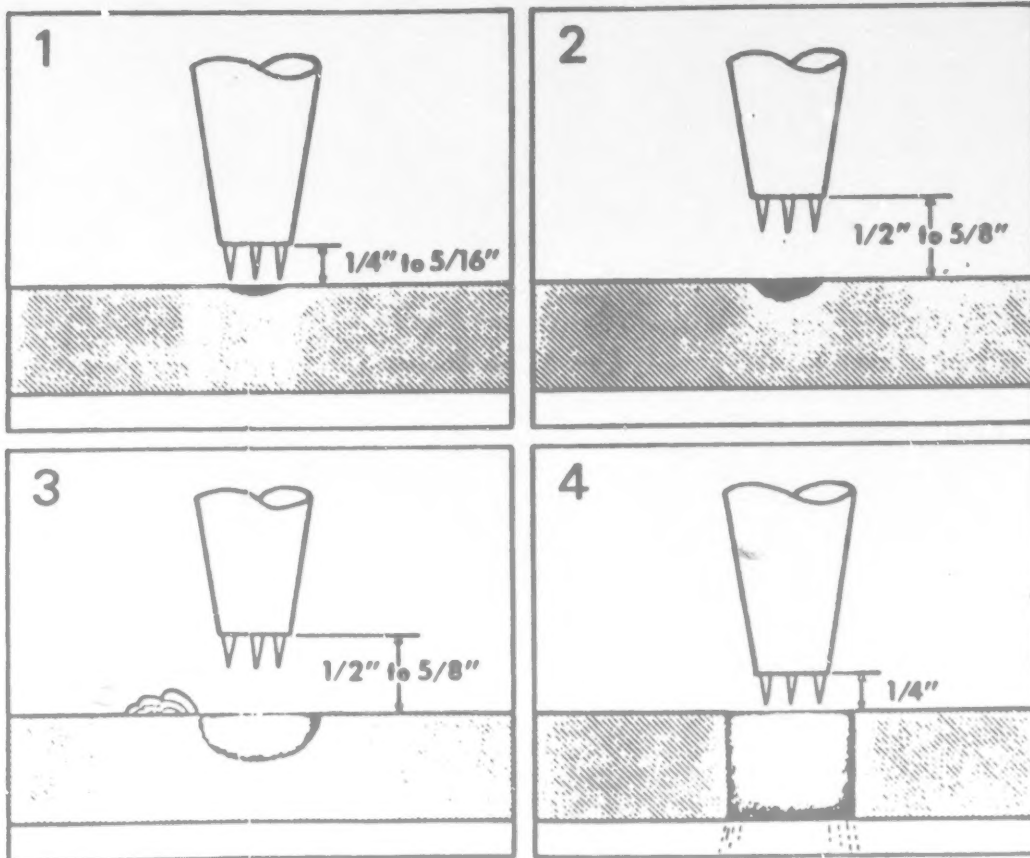
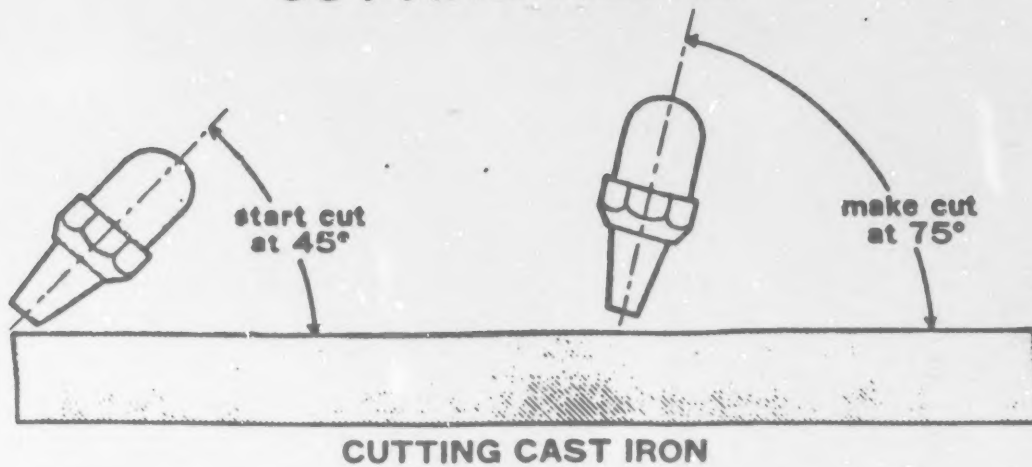


TORCH TIP SLANTED
TO START CUT

GRADUALLY MOVE TORCH TIP
TO PERPENDICULAR POSITION



CUTTING METAL



PIERCING HOLE

TRANSPARENCY II-2-1

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT III: Soldering

LESSON 1: Soldering Use and Procedures

I. Preparation for Instruction

A. Objectives

1. Terminal: Demonstrate procedures necessary for soldering metals.
2. Specific:
 - a. Explain the purpose of soldering.
 - b. Describe and select the tools and equipment used in soldering.
 - c. List the factors important for good soldering.
 - d. Describe the procedure for applying solder.
 - e. Demonstrate soldering procedure for joints and seams on metal.
 - f. Demonstrate procedure for soldering holes.
 - g. List the various metals that may be soldered.

B. Review of Teaching Material

1. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Printers and Publishers, Inc., 1977.
2. Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York: Macmillan Company, 1960.

C. Special Arrangements

1. Secure $\frac{1}{4}$ " and $\frac{1}{2}$ " steel rods.
2. Secure $\frac{1}{2}$ " plate steel.

II. Presentation of Lesson

A. Motivation

Discuss need for being able to make bolts and thread/
rethread holes in metal.

B. Content Outline

1. Purpose of Soldering

- a. Soldering is a process of joining two pieces of metal by means of another metal or alloy having a lower melting point than the two metals to be joined.
- b. A 50-50 mixture of tin and lead is the most commonly used solder mixture for shop work. It melts at 400 degrees F.

2. Tools and Equipment

- a. Flux -- Flux is an aid used to destroy the oxide in the metal to be soldered and clean the surface to allow the solder to stick to the metal. If flux is not used, the thin coat of oxide forming after cleaning the metal will prevent the solder from adhering. Zinc Chloride is the best flux for most jobs on the farm. It will work on most metals.
- b. Propane Torch -- A propane torch is a convenient and easily obtainable source of heat for soldering. It produces no carbon, soot, or smoke, and will function in the wind. (Transparency III-1-B)
- c. Nonelectric Soldering Irons -- This type of soldering iron is made of copper. It is used for melting and applying solder. A soldering copper must be "tinned." This is done to keep the copper clean, cause the copper to pick up and spread the solder evenly, and to prevent acid flux from corroding the copper. It must be heated by a blow-torch or some other exterior source of heat. (Transparency III-1-A)

Tinning is done as follows: (Transparency III-1-B)

- 1) Heat soldering iron to a red heat and file each face until it is smooth and bright.
- 2) Rub the hot faces of the copper on a sal ammoniac brick.
- 3) Apply a small amount of solder to the copper as it is rubbed on the sal ammoniac.
- 4) Continue applying solder and rubbing until the entire point is covered with "tin."
- 5) Remove excess solder from the copper by wiping it quickly with a damp rag.

- d. Electric Soldering Gun -- The soldering gun produces intense heat at the point of application. It is excellent for use on small parts and when there is a flame hazard. It operates on 115 volts and ranges in operating temperature from 500-600 degrees F. (Transparency III-1-A)
3. Factors for Good Soldering:
- a. Clean, hot source of heat,
 - b. Hot, well-tinned soldering iron,
 - c. Clean metals to be soldered,
 - d. Good quality flux, and
 - e. Metal heated enough to prevent solder from "setting" too quickly.
4. Applying Solder
- a. Clean all parts to be soldered. This may be done by scraping, filing, grinding, or sandpapering. New metal can be cleaned using emory cloth or sandpaper.
 - b. Apply flux after the metal is cleaned and just before soldering to help the solder stick.
 - c. Heat the soldering iron.
 - d. Place iron against the solder to cause a little solder to stick on it.
 - e. Apply the point to the parts to be soldered.
 - f. Allow time for the metal to heat as the solder is applied. The solder may even be held against the iron and run down to the metal being soldered.
5. Soldering joints -- seams (Transparency III-1-C)
- a. Clean joint thoroughly.
 - b. Hold the iron against the metal and move back and forth along the seam to preheat a 4-6 inch section.
 - c. Apply flux to the lapped surfaces of the seam. Apply a thin layer of solder to both surfaces.
 - d. Place both surfaces together. Apply heated copper to the seam, holding the copper at the same point until the solder under the seam has melted. Steps b, c, and d are called tinning and sweating the joint.

- e. Melt a small amount of solder at the point of the copper, then tilt the copper over, until a corner of it is in the seam.
- f. Move the copper slowly down the seam while applying more solder as needed to solder the entire seam with one pass.

6. Soldering Holes

- a. Clean surface around hole until bright.
- b. Clean inside hole with a file.
- c. Heat metal.
- d. Apply flux to metal and add solder to the point of the copper. Tin a small area around the hole using a small amount of solder.
- e. Add a small amount of solder to the point of the copper and place the point in the hole.
- f. Rotate the copper back and forth several times then lift the copper away.

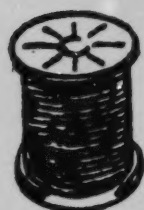
7. Metals That Can Be Soldered

- a. Tin
- b. Galvanized iron
- c. Copper
- d. Cast iron
- e. Enamelware
- f. Zinc
- g. Lead pipe

C. Suggested Student Activities

- 1. Each student will obtain a one gallon bucket with holes punched in the bottom to be soldered. When the process is complete, the bucket should not have any leaks present.
- 2. Obtain electrical wire for students to use in soldering wire together. Allow the students to make the proper splice and complete a solid connection by soldering the splice.

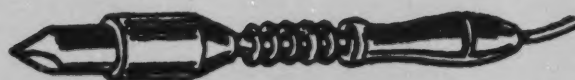
SOLDERING EQUIPMENT



SOLDER



PASTE



ELECTRIC SOLDERING IRON

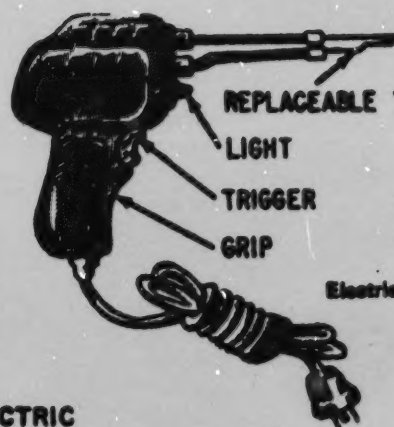


BLOW TORCH



GUN

Soldering equipment.



REPLACEABLE TIP

LIGHT

TRIGGER

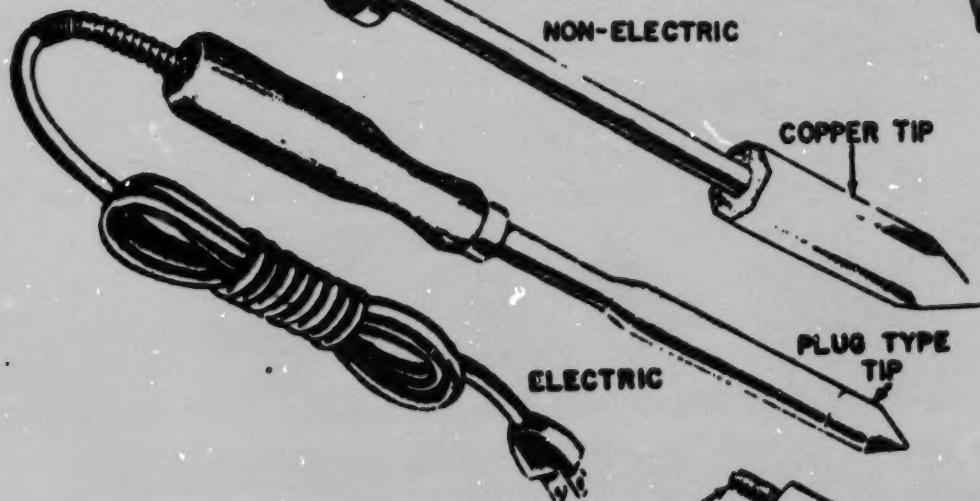
GRIP

Electric soldering gun.



HANDLE

NON-ELECTRIC



ELECTRIC

COPPER TIP

PLUG TYPE TIP

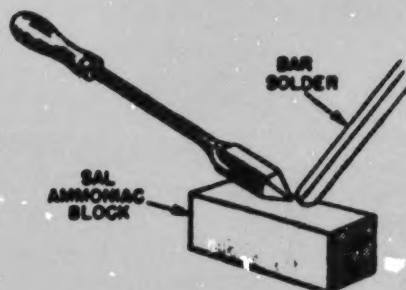
SCREW TIP

SOLDERING EQUIPMENT

Propane Torch

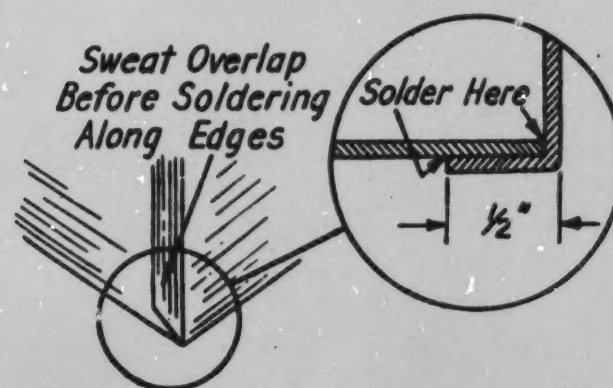
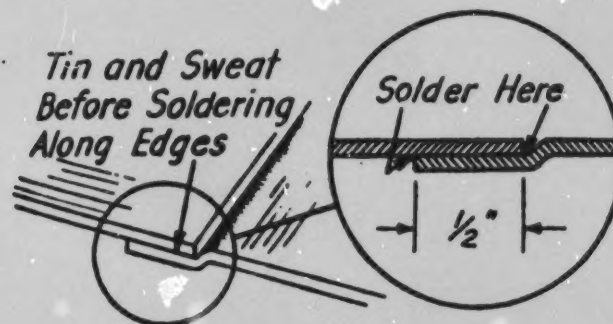
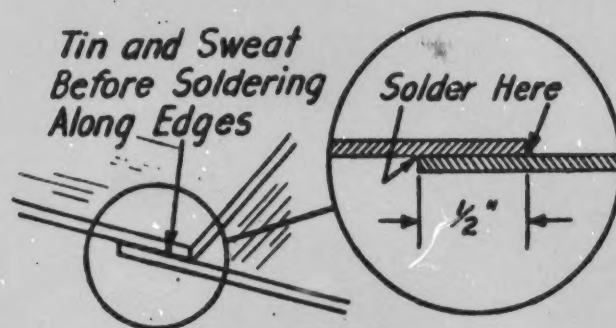


Tinning A Soldering Iron



TRANSPARENCY III-1-B

SOLDERING JOINTS



TRANSPARENCY III-1-C

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 1: Safety

I. Preparation for Instruction

A. Objective

1. Terminal: Demonstrate safety procedures for electrical wiring.
2. Specific:
 - a. Identify proper clothing to wear for electrical work.
 - b. Explain the importance of grounding a circuit.
 - c. Describe procedures for proper use of tools and equipment.
 - d. List wiring precautions.

B. Review of Teaching Material

1. Colvin, T. S. Electrical Wiring Residential, Utility, Buildings, and Service Areas. Athens, Georgia: American Association for Vocational Instructional Materials, 1981.
2. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Printers and Publishers, 1977.

C. Materials Required

1. Poster board
2. Magazines
3. Colored markers and pencils

II. Presentation of Lesson

A. Motivation

Discuss hazards resulting from poor safety practices when working with electricity and electrical items.

B. Content Outline

1. Clothing

- a. A hard hat and steel-toed shoes aid in protection against falling objects.
- b. Rubber heels and soles with no nails help insulate against electrical shock.
- c. It is important that loose clothing should not be worn when doing electrical work. In addition, rings or metal watchbands should not be worn because they tend to catch or hang on projections.
- d. Safety glasses should be worn to prevent eye damage from flying particles or pieces of wire.

2. Grounding

- a. The purpose of grounding any circuit is safety. If an installation is not grounded properly, it is extremely dangerous with respect to shocks, fires, damage to appliances, and motors. Good grounding also minimizes damage from lightning, especially on the farm.
- b. There are two categories of grounding. One is system grounding in which the current-carrying wires of the installation are grounded. The other category is equipment grounding which involves the grounding of the frames of motors, equipment cabinets, and metal conduct.
- c. Refer to the Agricultural Mechanics instructional area, Unit IV, Lesson 2, in the Basic Vocational Agriculture I and II materials.

3. Use of Tools and Equipment

- a. Use tools that are double insulated, if possible, as they will provide protection against electrical shock. In addition, protection can be provided by using hand tools such as screwdrivers and pliers that have insulated handles.
- b. Keep tools in good working condition. Cutting tools should be kept sharp. Always check cords and plugs on all power tools. Properly remove plugs by grasping the plug and pulling directly on the plug. Never jerk on cords to remove them from electrical outlets. If extension cords cross a traffic area, shield them with planks or other protection measures.

- c. Keep work area clear of obstacles to prevent injuries caused by tripping and falling.
- d. When working with electricity, use only wooden or fiberglass ladders. It is preferable to use ladders with rubber or nonslip feet. Do not leave tools lying on the steps. Make sure all braces are locked in place and do not use the top two steps for standing.
- e. Protect oneself when working in damp areas by standing on a rubber mat, wooden platform, or other nonconducting material. Never stand on wet ground or a damp floor when working with power tools or doing electrical work.
- f. Always be sure that work is not being done on a "hot" electrical circuit. Disconnect power to the branch circuit before working on wiring or equipment. Do this by turning the main service-entrance switch off. Another method is to remove the branch-circuit fuse or cut the circuit breaker to the "off" position. Test the circuit to make sure it is not live by plugging in a lamp or circuit tester.

4. Wiring Precautions

- a. Do not allow bare wires to touch.
- b. Use electricians' tape to insulate wires from each other.
- c. Do not touch switches with wet hands or while standing in water.
- d. Do not overload the line. Make sure proper amperage is considered when installing fuses and circuit breakers.
- e. Do not install fuses that are larger than recommended for the circuit. This may cause damage to equipment and/or fire.
- f. Do not touch bare wires with hands or other tools while the line is "hot."
- g. Do not touch two wires together to see if they are "hot."
- h. Always open the circuit before touching any point on the circuit.

C. Suggested Student Activities

1. Students will divide into groups of two. Each group will develop a poster-board display illustrating the safety rules outlined in the lesson.
2. The instructor will create and set up mock hazardous situations and allow students to demonstrate proper safety procedures.
3. Students will divide into groups of two and demonstrate to the class an assigned safety procedure for working with electrical wiring.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 2: Service Entrance

I. Preparation for Instruction

A. Objectives

1. Terminal: Identify and install the components of an electrical service entrance.
2. Specific:
 - a. Identify components of the service entrance.
 - b. Identify the two types of service entrance panels.
 - c. Determine the size of the service entrance panel.
 - d. Install the service entrance panel cabinet.
 - e. Mount the service drop.
 - f. Install service entrance cable.
 - g. Connect the service entrance wiring.
 - h. Connect the circuits in a service entrance panel.

B. Review of Teaching Material

1. Colvin, T. S. Electrical Wiring: Residential, Utility, Building, and Service Areas. Athens, Georgia: Association for Vocational Instructional Materials, 1981.
2. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Printers and Publishers, 1977.

C. Special Arrangements

1. Secure lumber and nails for wall construction to be used in a student exercise.
2. Obtain service entrance panels, wiring, and circuit breakers.

II. Presentation of Lesson

A. Motivation

Show illustration of good wiring and poor wiring practices. Discuss the results of the danger involved and the expense of poor wiring. (Especially wiring, stressing that this is important regarding the service entrance connection.)

B. Content Outline

1. Components of Service Entrance

- a. Insulators on outside of building
- b. The meter socket
- c. Cable for wires in conduit from the insulators to the meter socket and into the building
- d. Disconnection equipment and overload protection devices (circuit breakers or fuses)
- e. Ground connection

2. Types of Service Entrance Panels (SEP)

- a. Fuse-type -- This type of panel usually costs less but is inconvenient to use. When a fuse "blows" because of a circuit overload, it must be replaced.
- b. Circuit-breaker type -- This type of breaker is almost totally used in new structures. When tripped because of overload, the circuit breaker is simply reset after correcting the problem without having to replace it. Circuit breakers are available in sizes to protect any circuit desired. They are rated in amperes and carry 80 percent of the rated capacity continuously. The circuit breaker main switch is a heavy-duty 2-pole off-on switch that will turn off all power to the panel.

3. Size of Service Entrance Panel

- a. The size of the Service Entrance Panel refers to the total ampere capacity of the entire panel. Normally, the SEP is rated as 100, 150, or 200 amperes. Usually 100 amperes is considered a minimum requirement. If a structure has electric heat or air conditioning, and electric water heater, 150 or 200 amperes will be required.
- b. Demand factors are considered when rating the amperage requirement for a SEP. One method is the following:
 - 1) Include 1500 watts for each two-wire, 20-ampere small appliance circuit.
 - 2) Three watts per .09 square foot of the house for general lighting and general-use receptacles.

3) List the nameplate ampere rating of all fixed appliances, ranges, wall mounted ovens, and counter-mounted cooking units.

4) List the nameplate ampere or KVA rating of all motors and of all low-power-factor loads.

Multiple amperes x volts if motor rating is given in amperes.

5) Use the largest of the following:

a) Air-conditioning load at 100 percent

b) Sixty-five percent of the total demand of the central electric heating load

Use only one of the above in the total.

6) Compute the calculated load. Find the total load in watts and divide by 230 volts to determine the ampere rating for the total requirement for the SEP.

4. Mounting the SEP Cabinet

The steel SEP cabinet is normally mounted into a wall by securing it to the studs on either side of it. The front of the cabinet will line up so as to allow for the finished wall surface.

5. The Service Drop

a. The service drop is the cable or wires that extend from the power company transformer to the structure. It is usually installed by the power supplier. It is usually composed of two black insulated wires and one bare neutral wire which provide a 120/240 volt service. (Transparency IV-2-A)

b. The procedure is as follows:

1) Select a location for the insulator rack.

2) Check ground clearance -- (Transparency IV-2-B)
The ground clearance is determined by the type of area over which the wires extended and the voltage passing through the wires. Most service drops are 10-15 feet above ground level. It is recommended that a 15 foot clearance be maintained over residential property.

- 3) Check roof clearance -- If the roof slope is not less than 4 in 12 inches and voltage is not over 300 volts, a 3 foot clearance is permitted.
- 4) Check for window clearance -- There should be a clearance of not less than 3 feet for windows, doors, etc.
- c. To mount the service drop rack, fasten the cable to the side of the house by means of an insulator rack. Locate the entrance head above the service drop to allow room for drip loops. A drip loop prevents water from entering the entrance head. (Transparency IV-2-C)

6. Service Entrance Cable Installation

- a. Measure and cut cable for installation between entrance head and meter base. Be sure to add $3\frac{1}{2}$ feet for connections at entrance head and meter base. (Transparency IV-2-D)
- b. Remove about 3 feet of outer jacket from the cable.
- c. Prepare neutral wire for installation by unwrapping the separate strands and twisting together to form a base conductor.
- d. Install wires in entrance head.
- e. Install the entrance head by mounting it 12 inches higher than the insulator rack.
- f. Install meter base about $4\frac{1}{2}$ -5 feet above the ground unless otherwise specified. (Transparency IV-2-D)
- g. Attach connectors to the meter base. A watertight connector is installed at the top. (Transparency IV-2-E)
- h. Insert the end of the cable from entrance head through the top meter base opening and tighten connector on the cable. There should be 6-8 inches of cable inside the meter base. (Transparency IV-2-E)
- i. Drill hole through wall for cable.
- j. Measure and cut cable length to reach service entrance panel. Add 14-24 inches.

k. Install cable between meter base and the SEP by inserting wires in bottom outlet of meter base. Insert cable into meter base connector and tighten. Place cable through the wall and pull to SEP. About 6 to 14 inches of cable should extend inside the panel box. (Transparency IV-2-E) Install sill plate, where required, to seal the hole where the cable enters the building. (Transparency IV-2-F) Finally, install cable straps $4\frac{1}{2}$ feet apart and 12 inches from meter base.

l. Connect cable to meter base terminals by connecting the insulator cables to the upper and lower line terminals, and the neutral base wire will connect with the center neutral terminal. (Transparency IV-2-G)

7. Connect Service Entrance Wiring

a. The inside of the service entrance cabinet includes the main breaker or fuse pull-out, the neutral bar, and the circuit breaker panel. (Transparency IV-2-H)

b. Procedure to connect service entrance conductors to service entrance panel terminals: (Transparency IV-2-I)

1) Connect the two hot conductors -- These are usually noted by being black or black and red. Insert each of the wires into the connector in the main breaker terminal.

2) Connect the neutral wire to the neutral bar terminal.

3) Ground and bond neutral bar to the panel cabinet -- A bolt or strap is usually provided for this.

c. Grounding procedure -- To ground the wiring system, a ground wire must be connected from the neutral bar on the SEP to an approved grounding electrode.

1) Most systems use a $\frac{1}{2}$ inch steel or iron rod for grounding purposes. This should be driven into the ground 8 feet.

2) Connect the grounding conductor at the neutral bar.

3) Connect the grounding conductor at the grounding electrode.

- 4) Bond the first grounding electrode to at least one other grounding electrode.

d. Connecting circuits in the SEP (120 volt)
(Transparency IV-2-J)

- 1) Extend the white wire and the base grounding line around the edge of the cabinet to the neutral bar.
- 2) Attach the white wire to the neutral bar.
- 3) Attach the base grounding wire to the neutral bar.
- 4) Insert the black wire under the screw in the circuit breaker and tighten the screw.
- 5) Insert the circuit breaker into the slot at one end and push the blade into the clip terminal.

e. Connecting circuit in the SEP (240 volts)

- 1) Connect the black wire to a terminal on the 240-volt circuit breaker.
- 2) Attach the white wire to the other breaker terminal. Put black tape on the end of the white wire to identify it as hot.
(Transparency IV-2-K)
- 3) Attach the grounding wire to the neutral bar.

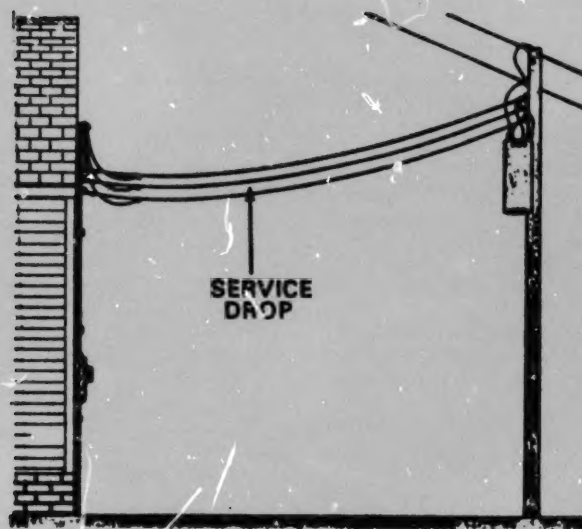
f. Connecting 120/240 volt circuits. (Transparency IV-2-K)

- 1) Attach white wire to the neutral bar.
- 2) Insert black (hot) wire under a terminal on a double-pole circuit breaker and tighten.
- 3) Insert the red (hot) wire under the other terminal on the circuit breaker and tighten.
- 4) Attach grounding wire to a neutral bar terminal.

C. Suggested Student Activities

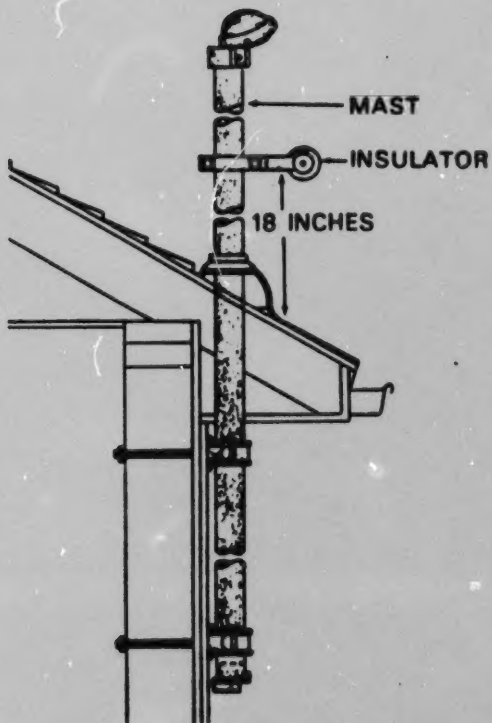
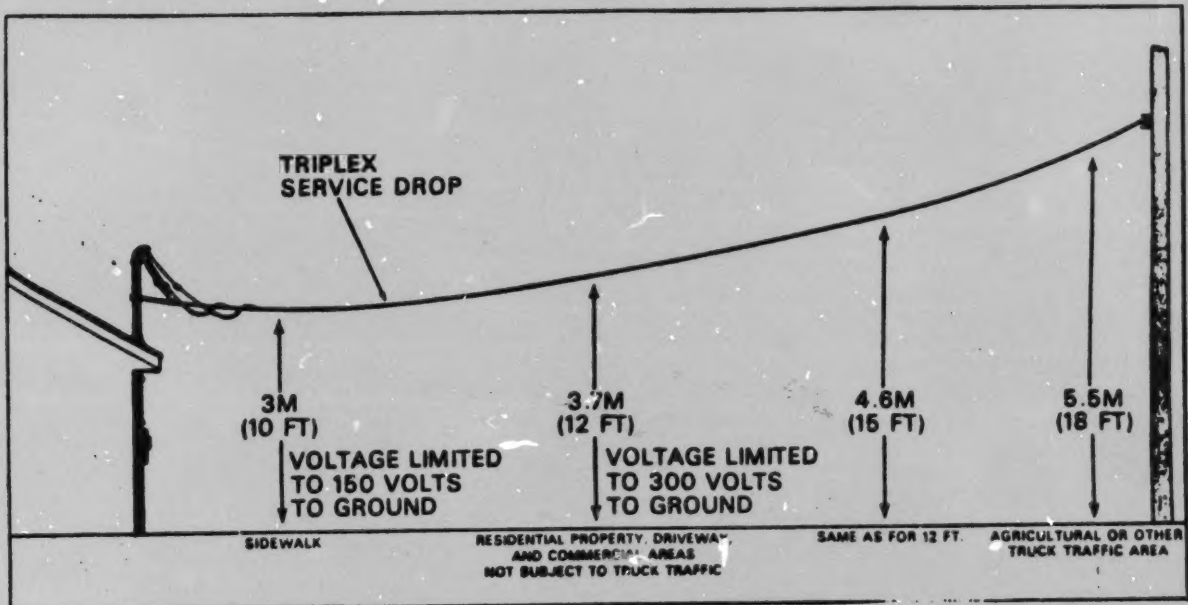
A pair of students will construct a studded wall 8 feet long and 8 feet tall. Each group of students will properly install a service entrance panel and properly connect two 120 volt circuits, two 240 volt circuits, and one 120/240 volt circuit with circuit breakers included.

THE SERVICE DROP

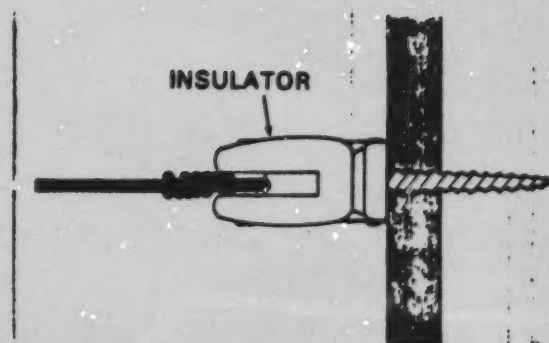
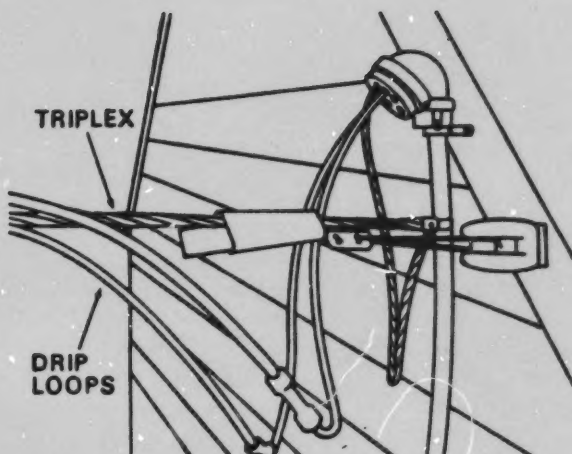


TRANSPARENCY IV-2-A

GROUND CLEARANCE FOR SERVICE DROP



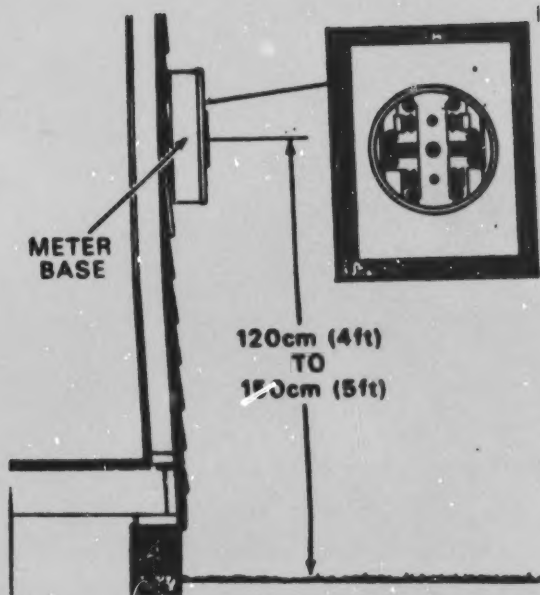
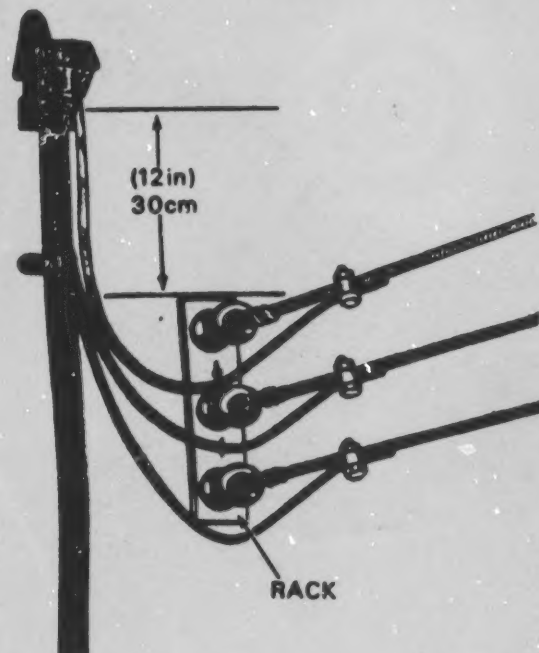
DRIP LOOP AT SERVICE HEAD



TRANSPARENCY IV-2-C

SERVICE ENTRANCE CABLE INSTALLATION

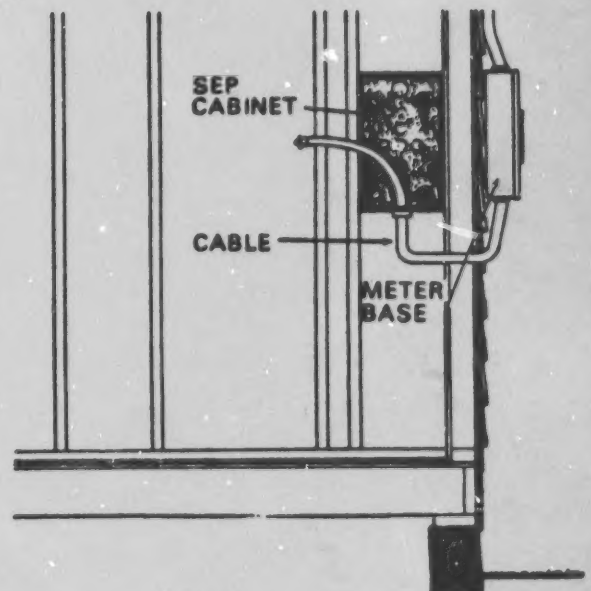
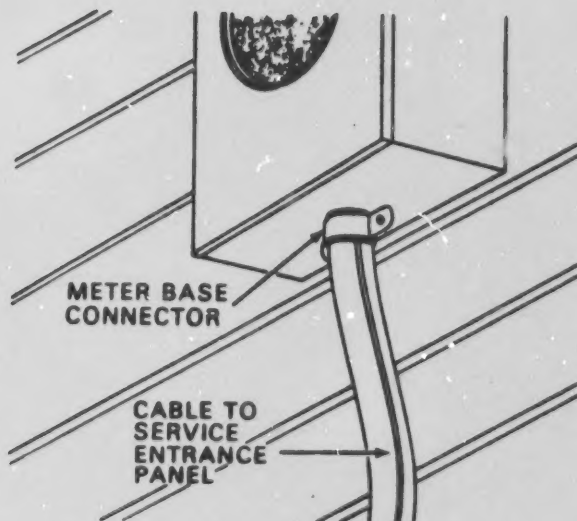
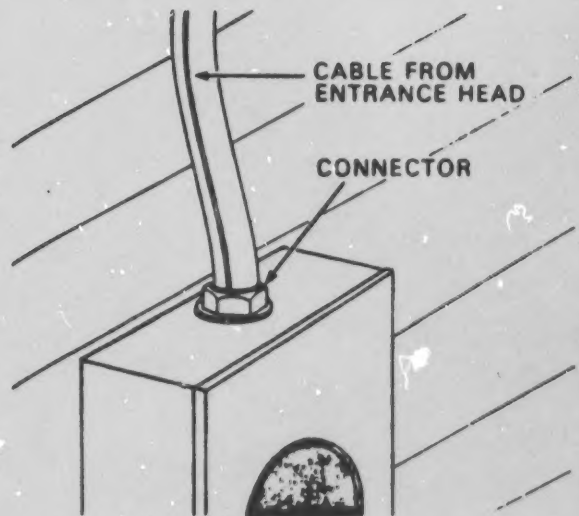
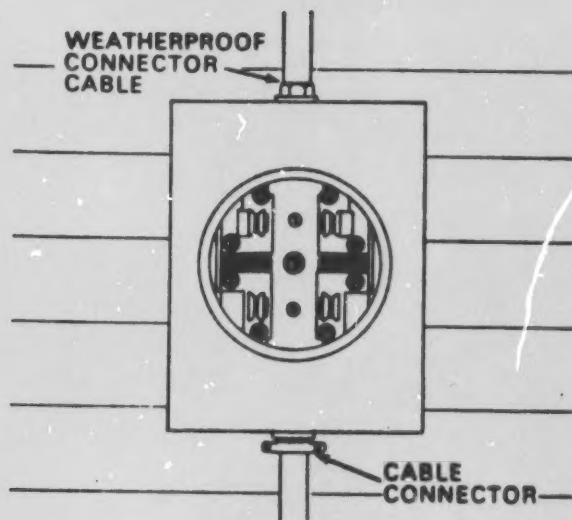
ADD 3.5 FEET FOR CONNECTIONS
AT ENTRANCE HEAD AND METER BASE.



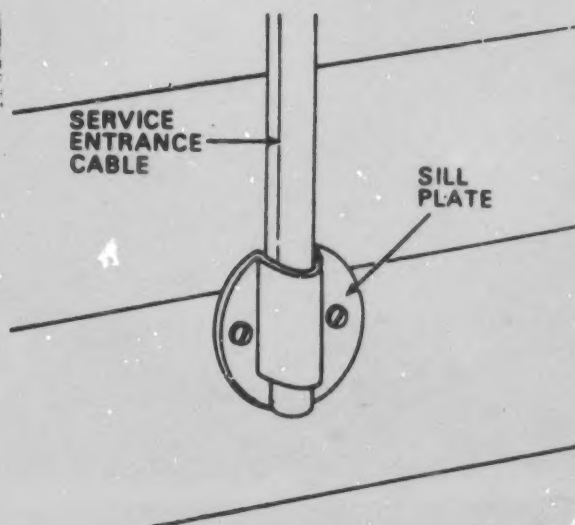
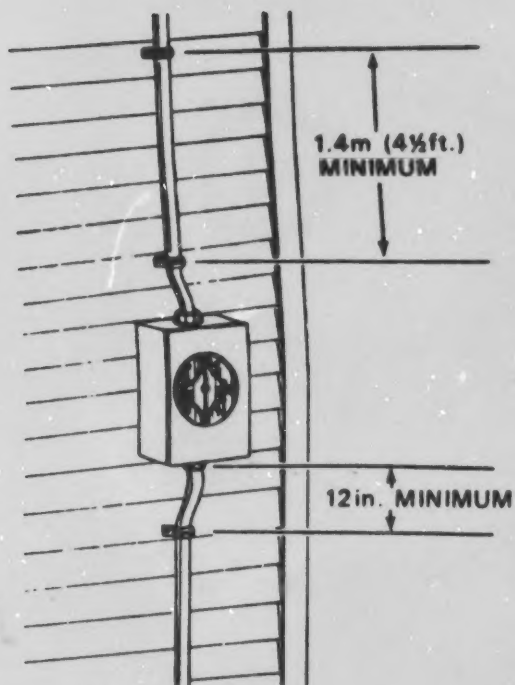
INSTALL METER BASE 4.5-5 FEET
ABOVE GROUND.

TRANSPARENCY IV-2-D

ATTACHING CONNECTION TO METER BASE

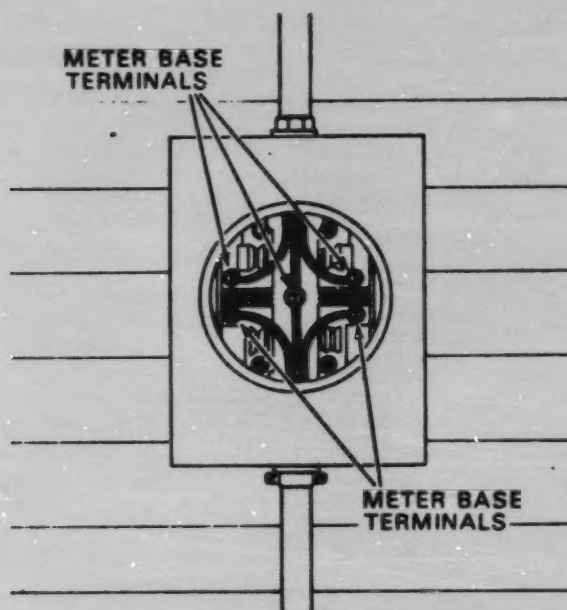


INSTALLING CABLE STRAPS



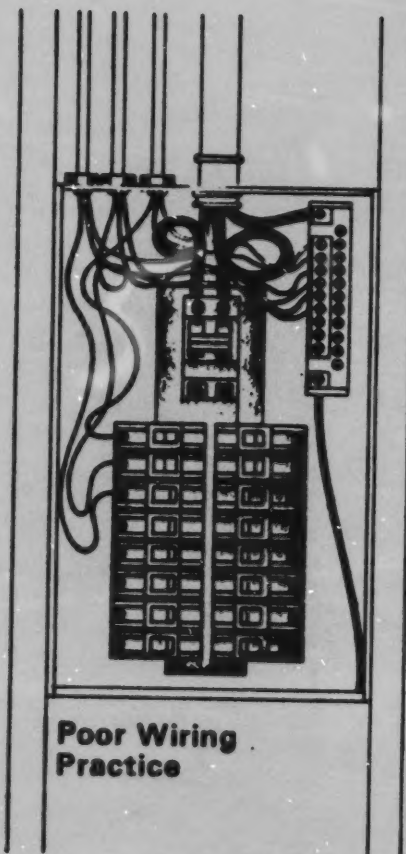
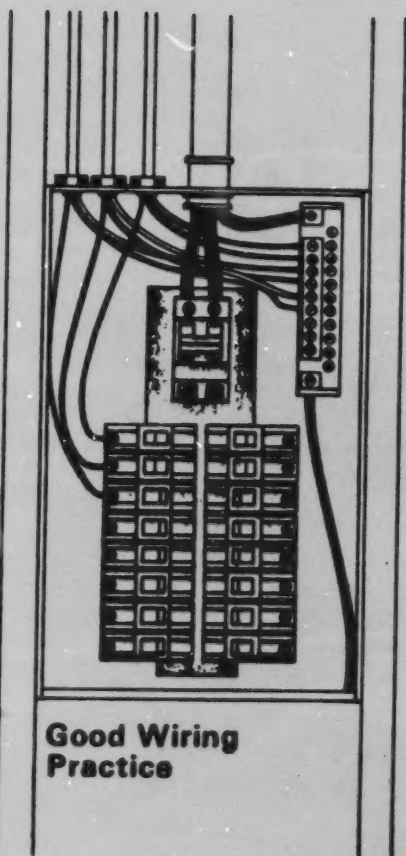
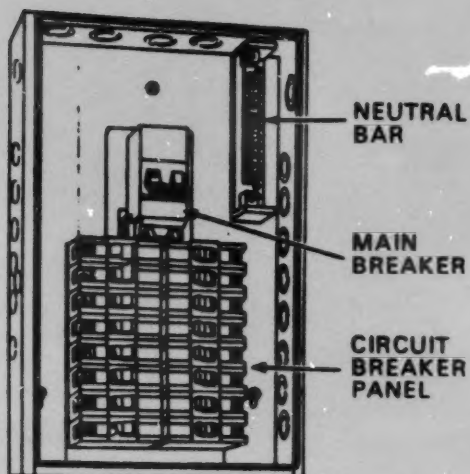
TRANSPARENCY IV-2-F

CONNECTING METER BASE TERMINALS

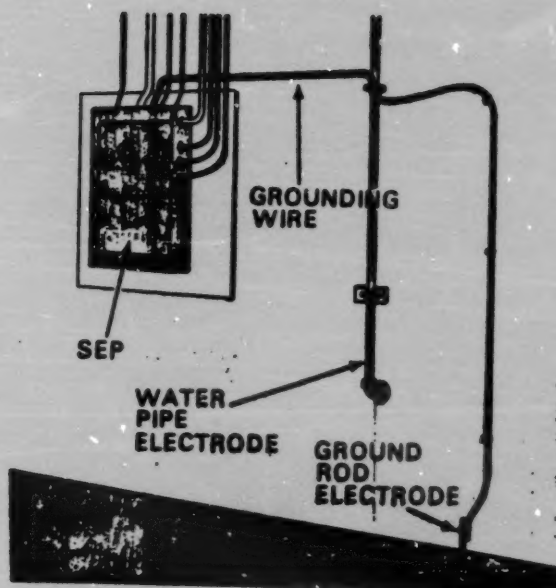
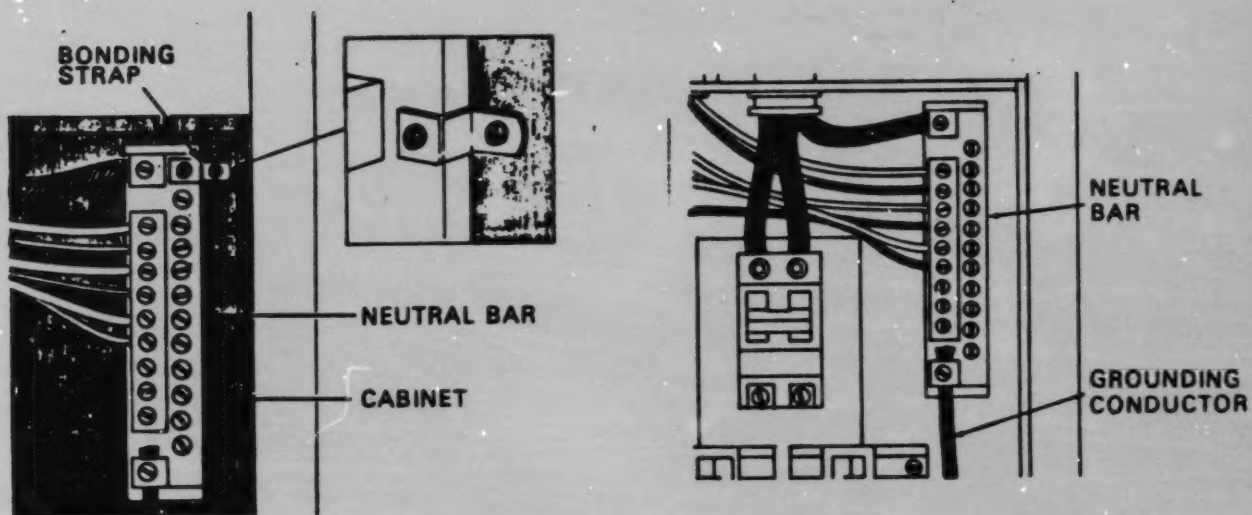


TRANSPARENCY IV-2-G

CONNECTING SERVICE ENTRANCE WIRING

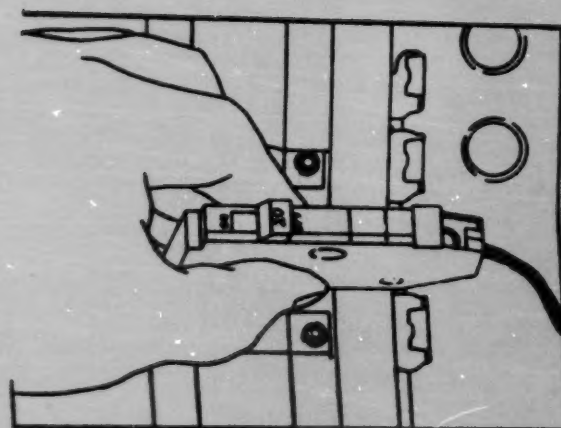
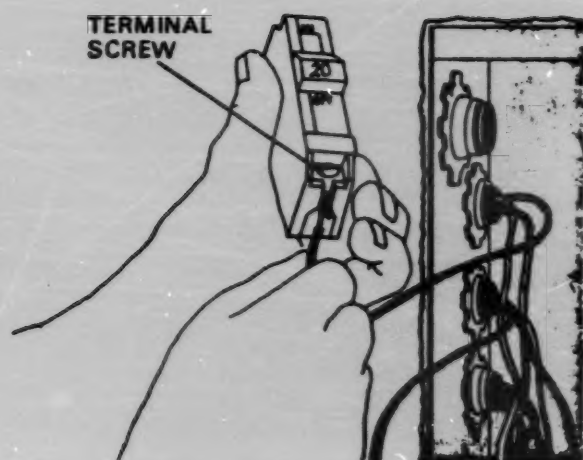
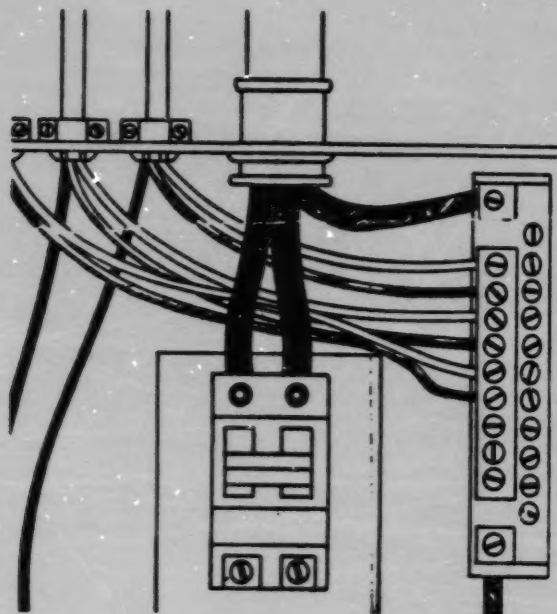


CONNECTING SERVICE ENTRANCE WIRING



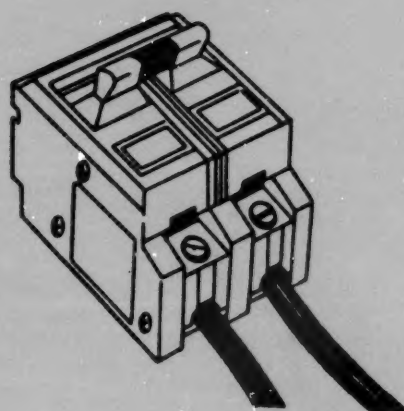
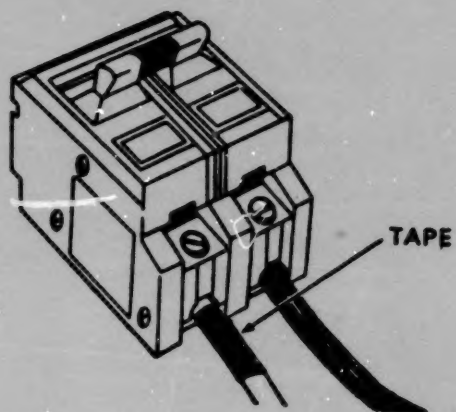
TRANSPARENCY IV-2-1

CONNECTING CIRCUITS IN THE SERVICE ENTRANCE PANEL



TRANSPARENCY IV-2-J

CONNECTING 240 VOLT CIRCUIT BREAKER



TRANSPARENCY IV-2-K

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 3: Selection of Electric Motors

I. Preparation for Introduction

A. Student Objectives

1. Terminal: Describe selection of electric motors.
2. Specific:
 - a. Determine the size motor to select.
 - b. Determine the motor speed to select.
 - c. Define the motor duty to select.
 - d. Select the proper type of motor.
 - e. Select the proper enclosure for a motor.
 - f. Determine the proper motor mount.

B. Review of Teaching Materials

1. Electric Motors: Selection, Protection, Drives. 4th ed., Athens, Ga.: American Association for Vocational Instructional Materials, 1978.
2. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishers and Printers, 1977.

C. Special Arrangements

1. Obtain different types of electric motors for display and discussion.
2. Ask an electric company representative to come to class to discuss selection of electric motors.

II. Presentation of the Lesson

A. Motivation

Discuss the many uses and advantages of using electric motors. Emphasize the labor and money saving quality of using electric motors.

B. Conduct Outline

1. Motor Size Determination

- a. Determine how much power is necessary in order to avoid selecting a motor too small or too large for the job. If one is replacing a portable engine it is acceptable to get a motor with $\frac{2}{3}$ to $\frac{3}{4}$ as much power as that engine.
- b. Availability of electric power is essential. (Transparency IV-3-A)
 - 1) Single phase (120 or 240 volt) -- This type of electric power is supplied to most farms and is the most common type available. Three wires usually extend from the pole to the electric motor.
 - 2) 3-Phase (240 volts or more) -- With this type of electrical power, four wires will extend from the pole to the motor. This is commonly used by industry for operation of electric motors.
- c. Service entrance capacity -- Normally, one service entrance should have three times more amperage capacity than is rated on the nameplate of the motor. This is necessary to allow for the line surge required to start the motor.

2. Motor Speed Selection

- a. Different items of equipment operate at different speeds. It is necessary to get a motor that will operate at the proper speed.
- b. Determine at what speed the equipment is to operate. This is measured in revolutions per minute (rpms).
- c. Most motors operate at no-load speeds of 3600, 1800, and 1200 rpm.
- d. If equipment requires a speed different from standard speeds, it will be necessary to buy a standard motor and use a speed-conversion drive system to attain the proper speed.

3. Motor Duty Selection

- a. Motor duty refers to the amount of time the motor is operating under full load and how much time it is stopped.

- b. There are two classifications of duty--continuous and intermittent.
 - c. Continuous types of motors are designed for constant full loads for more than 60 minutes at a time. This is the most common type of motor.
 - d. Intermittent types of motors are designed for continuous duty. Insulation and wiring are not as good and will not last long under full loads for long periods of time. They are designed for fully loaded periods of 5, 15, 30, or even 60 minutes.
4. Motor Type Selection -- Various motor types are grouped into two kinds of starting loads:
- a. Easy starting loads (Transparency IV-3-B)
 - 1) Shaded-pole induction -- This type of motor has a low starting torque of 50 to 100 percent of normal full-speed torque. This type of motor is for intermittent duty only. (Transparency IV-3-C)
 - 2) Split-phase -- This is good for torque of small loads and requires a starting torque of 100 to 150 percent of normal full-speed torque. It has the disadvantage of drawing from 6 to 8 times its normal running current when starting.
 - 3) Permanent-split, capacitor induction -- This motor has a low starting torque and is used on easy-to-start loads. The capacitor aids the ability of a motor to start a load.
 - b. Difficult starting loads (Transparency IV-3-B)
 - 1) Capacitor-start, Induction-run -- This motor will develop three times more starting torque than the same size split-phase type. (Transparency IV-3-D)
 - 2) Repulsion-start, Induction-run -- It is used with single-phase power and will develop a starting torque of 4 times its normal running torque.
 - 3) Capacitor-start, Capacitor-run -- It generates $3\frac{1}{2}$ to $4\frac{1}{2}$ times the normal running torque for starting. Its capacitors are used for both starting and running.

c. Other factors in selecting motor type:

- 1) Direction of rotation,
- 2) Costs, and
- 3) Maintenance.

5. Enclosure Selection (Transparency IV-3-E)

- a. Drip-proof -- This type of enclosure provides for easy movement of air through the end shield into the motor mechanism.
- b. Splash-proof -- This enclosure is designed to keep free water from splashing into the motor mechanism. Consequently, the openings in the casing must be reduced.
- c. Totally-enclosed -- This has no openings for outside air to circulate through the motor. An internal fan circulates only the air inside the housing. This may cause the motor to run a bit hotter than other types. The manufacturer indicates on the nameplate the amount of temperature rise each motor can withstand.
- d. Selection of the type of motor enclosure will depend on how much water or spray will come in contact with the motor. Dusty conditions must also be taken into consideration.

6. Mounting Base Selection

- a. The purpose of mounting base
 - 1) Anchor the motor in position.
 - 2) Provide means for tightening a belt drive.
 - 3) Align the motor.
 - 4) Reduce vibration on the motor.
- b. There are two general types of mounts:
 - 1) Rigid -- This is most commonly used.
 - 2) Cushioned -- This is used to dampen equipment vibration.

C. Suggested Student Activities

Each student must identify three types of motors that have been placed on a table in front of the classroom. The student will then describe that particular motor.

THREE PHASE SERVICE

SINGLE-PHASE



THREE-PHASE

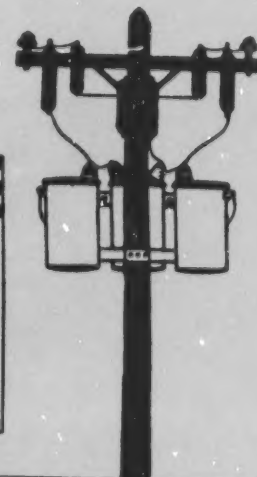


SINGLE-PHASE POWER IS LIKE ONE MAN DRIVING A TENT STAKE. THREE-PHASE POWER IS LIKE THREE MEN DRIVING THE SAME STAKE.

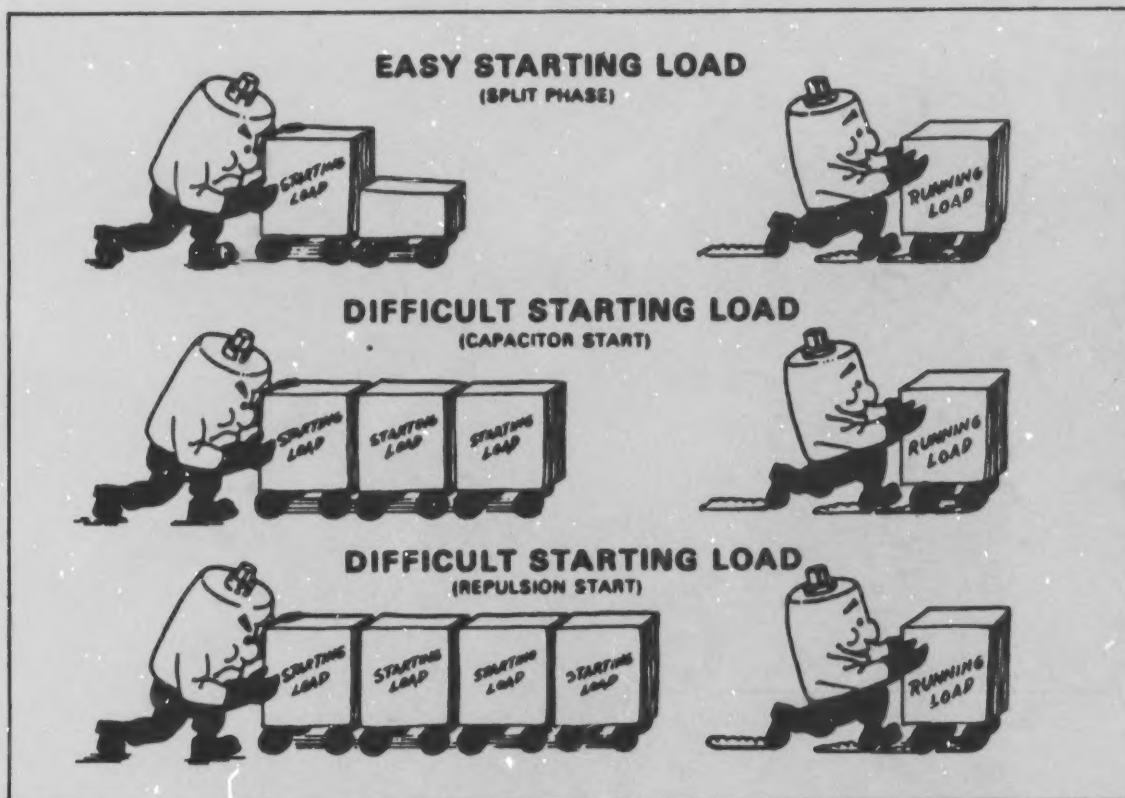
SINGLE-PHASE SERVICE



THREE-PHASE SERVICE



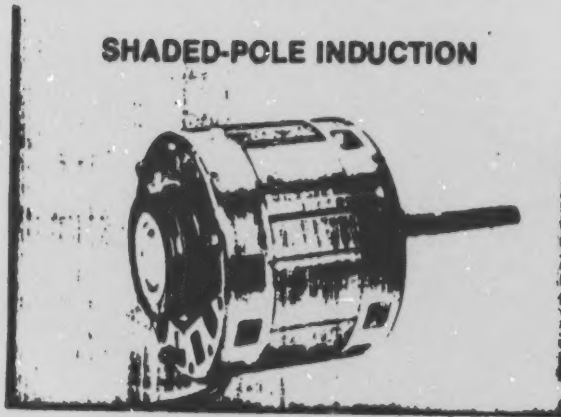
TYPES OF STARTING LOADS FOR MOTORS



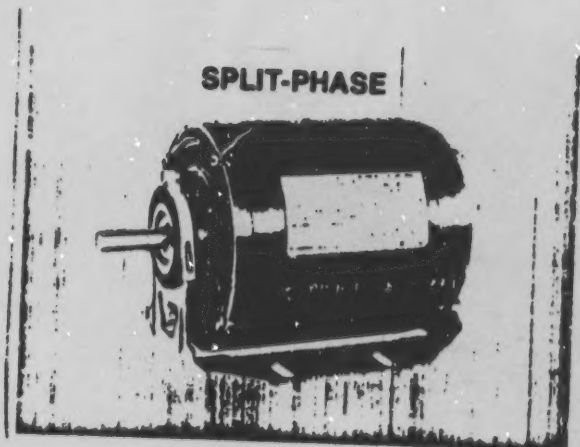
TRANSPARENCY IV-3-B

TYPES OF ELECTRIC MOTORS

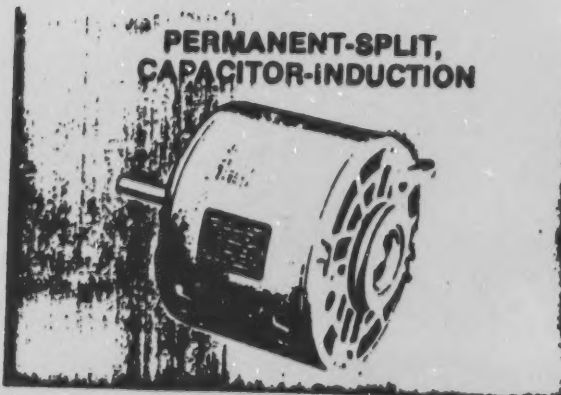
SHADED-POLE INDUCTION



SPLIT-PHASE

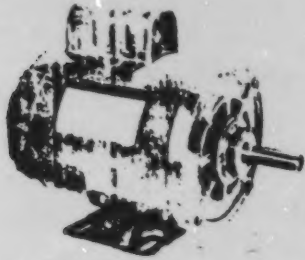


**PERMANENT-SPLIT,
CAPACITOR-INDUCTION**



TYPES OF ELECTRIC MOTORS

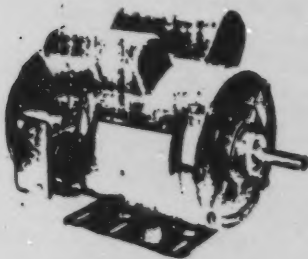
**CAPACITOR START,
INDUCTION-RUN**



**REPULSION-START,
INDUCTION-RUN**



**CAPACITOR-START,
CAPACITOR-RUN**



**THREE-PHASE,
GENERAL-PURPOSE**



TYPES OF ELECTRIC MOTORS

DRIP-PROOF



SPLASH-PROOF



TOTALLY-ENCLOSED



INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 4: Operating Electric Motors

I. Preparation for Instruction

A. Objectives

1. Terminal: Demonstrate the operation of electric motors, controls, and drives.
2. Specific
 - a. Describe how an electric motor operates.
 - b. Identify and describe the motor overload protection device.
 - c. Describe and select electric motor drives.

B. Review of Teaching Material

1. Brown, R. H. and G. E. Henderson. Electric Motors: Selection, Protection, Drives. 4th Edition, Athens, Georgia: American Association for Vocational Instructional Materials, 1978.
2. How Electric Motors Start and Run. Athens, Georgia: American Association for Vocational Instructional Materials, 1980.
3. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishers, 1977.

C. Special Arrangements

Arrange for a local business that repairs or specializes in electric motors to give a demonstration on pulley selection and use of electric motors for various jobs.

D. Materials Required

1. Electric motors
2. Different kinds of belts used with electric motors

II. Presentation of Lesson

A. Motivation

Discuss and illustrate the numerous items of equipment that can be operated by using electric motors. This application of electric motors is especially true on the farm and in agriculture-related businesses.

B. Content Outline

1. Electromagnets (Transparency IV-4-A)

- a. An electromagnet is similar to a permanent magnet but can be made stronger. This is the type used in electric motors. To produce an electromagnet, wrap insulated wire around an iron rod. This rod is called the core. When an electric current flows through the wire, the iron core becomes magnetized. It has an "N" pole and an "S" pole. These poles can be reversed by changing the direction of current flow. Alternating current changes direction on its own and, consequently, the poles in the electromagnet change. It is important to note here that when two magnets are placed close to each other, like poles repel each other while unlike poles attract each other. (Transparency IV-4-B)
- b. In an electric motor there are two types of magnets—a stationary electromagnet called a "stator" and a rotating magnet called a "rotor." The alternating current causes the polarity of the electromagnet (stator) to change many times in a second. If like poles are placed near each other, the free-turning magnet will rotate. This continual repelling of like poles will cause the rotor to turn at a high rate of speed. (Transparency IV-4-C)
- c. Most motors operating on alternating current use rotors of a special design called squirrel-cage rotors because it resembles a cage for exercising squirrels. (Transparency VI-4-D) This rotor consists of circular end rings joined with metal bars. These bars are placed opposite each other. Rotors normally have several bars. Electric motors with squirrel cage rotors are called induction motors. Only the stator has outside electrical connections. The rotor has no electrical connection. Rotor current is induced (generated) within the rotor itself.

2. Motor Overload Protection

A motor will not be damaged by more current than normal flowing through it for a short time. However, it will burn out if the overload is continued for a considerable time. It is therefore necessary to protect a motor with a device that will allow the high starting current to flow for a short time but will disconnect the motor if current from the overload flows through it for a longer period. These devices are called overload devices.

a. Types of overload devices

- 1) Manual-reset type -- This type of device must be reset by pressing a button before the motor will start again. This is the best type to have because it prevents the motor from coming back on before the operator is ready. (Transparency IV-4-E)
- 2) Automatic-reset type -- This type operates without manual assistance. When the heater in the control cools, the bimetallic disk snaps back into place and the motor restarts or tries to if still overloaded. (Transparency IV-4-F)
- 3) Manual starting switch with overload protection -- This control is usually equipped with a heater strip (or coil) with an amperage rating matching the motors or not more than 25 percent greater. It is important to install the right one in the control at the time it is purchased. (Transparency IV-4-G)
- 4) Magnetic starting switch with overload protection -- As current flows through the motor circuit, heat is given off but not enough to cause the bimetallic overload control switch to open unless there is continuing overload on the motor. If it does continue, the extra heat causes the bimetallic strip to open the switch and open the solenoid circuit which operates the magnetic starting switch. The motor stops and must be manually reset and started.
- 5) Time-delay fuse in motor disconnect switch (Transparency IV-4-H)
 - a) This fuse allows for temporary overloads such as a motor starting equipment already connected. It is similar to a regular fuse except it has a spring and solder cup. When heat from an overload extends long enough, it will soften the solder enough for the spring to pull the fuse link out of the solder.
 - b) Time-delay fuses are available in plug and cartridge types. (Transparency IV-4-I)
- 6) Current-limiting starters

These devices are used primarily on large electric motors and are often required by power

suppliers on 7.5 hp or larger single-phase motors.

b. Effects of motor size on control selection

- 1) For motors of less than 2 hp, built-in overload protection is provided in the motor.
- 2) For motors $\frac{1}{2}$ to 3 hp, a manual starting switch with overload protection may be used.
- 3) For motors 5 hp or larger, magnetic starting switches with overload protection should be used.
- 4) A time-delay fuse may be used on any size motor.
- 5) If a motor is 7.5 hp or larger (single-phase), a current-limiting starter and manual starting switch with overload protection is recommended.

3. Motor Drives (Transparency IV-4-J)

a. Direct drive -- This is used when the equipment turns the same speed as the motor.

- 1) Flexible-hose coupling -- The ends of the hose are clamped over the ends of the motor and equipment shaft.
- 2) Flange coupling -- One half of the flange is fastened to the motor shaft and equipment shaft. A flexible disk is placed in between the two halves and they are fastened together. In this case, the shafts must be in perfect alignment with each other.
- 3) Cushion-flange coupling -- This is a tire-shaped segment to which two flanges are attached.
- 4) Flexible shaft -- It is important when purchasing a flexible shaft to buy one that will be run in the direction for which it was built. This is especially true if the equipment must be turned in a certain direction.

b. Speed-conversion drive (Transparency IV-4-K)

1) Pulley and Belt Drive (Transparency IV-4-L)

- a) V-Belt
- b) Webbed V-Belt

- c) Flat Belt
- d) V-Flat
- 2) Gear drive
- 3) Chain-and-Sprocket drive
- c. Determining size of direct drive needed
 - 1) For motors of 1/3 hp or less, use a flexible hose coupling.
 - 2) If the motor is 1/3 hp or more, the flanged or cushioned type of coupling may be used.
 - 3) A flexible shaft can be used for any motor up to 2 hp.
- d. Determining type and diameter of pulleys needed
 - 1) Type
 - a) Standard V-pulley -- This is selected when the motor will be used for one job.
 - b) V-step pulley -- This type is used when a variety of speeds may be required by different items of equipment.
 - c) Adjustable V-pulley -- This pulley allows for adjustment in and out to give more or less diameter.
 - 2) Diameter of pulley

Pulley selection formula

$$\begin{array}{ccccccc} \text{RPM of motor} & & \text{Diameter of} & & \text{RPM of} & & \text{Diameter of} \\ \text{pulley} & \times & \text{motor pulley} & = & \text{equipment pulley} & \times & \text{equipment pulley} \end{array}$$

- 3) Determine length of V-belt needed

If the motor is already mounted, the length must simply be measured around both pulleys and between the motor and equipment, using a measuring tape. If the motor does not have to

be mounted in a certain place, the length can be determined using the following formula.

4 X diameter of largest pulley _____

1.6 X diameter of motor pulley _____

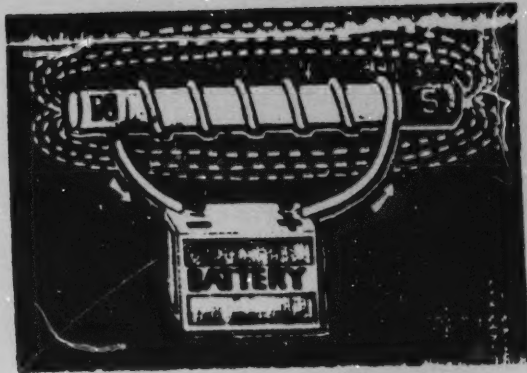
1.6 X diameter of equipment pulley _____

Total length _____

C. Suggested Student Activities

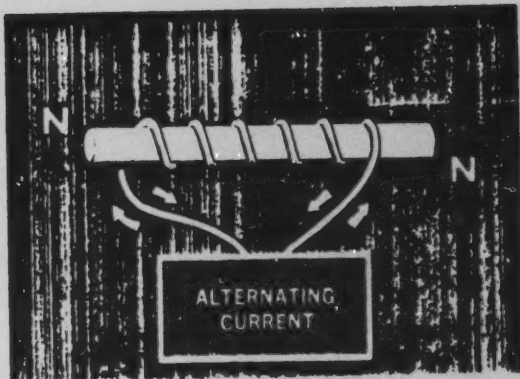
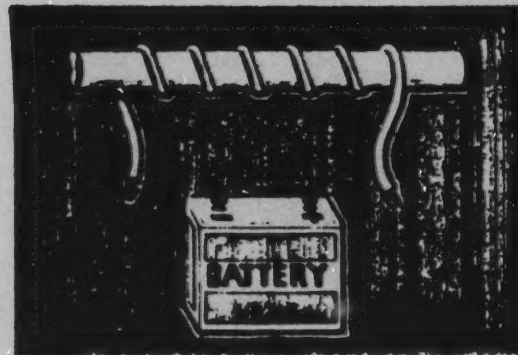
1. Divide the students into groups. Allow each group to properly install one or more of the electric motor overload devices. This could be done with a special plywood surface designed and constructed for this purpose.
2. Each student will prepare and submit a written and illustrated paper on motor drives. This will acquaint the student with the types of drives and what they look like.
3. The instructor shall develop student exercises that require determination of the type and diameter of pulley to be used for an assigned job and electric motor requirement.

OPERATION OF AN ELECTROMAGNET



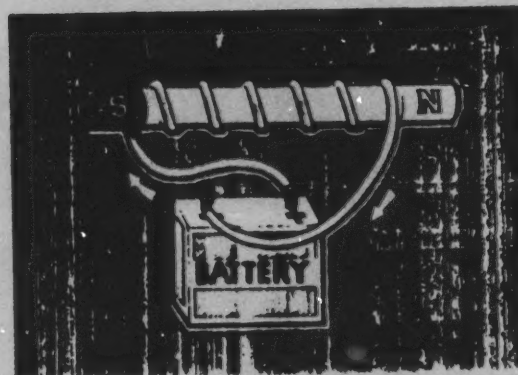
- A. ELECTRIC CURRENT FLOWS THROUGH THE WIRE TO MAGNETIZE THE IRON CASE.

- B. WHEN WIRE IS DISCONNECTED, CURRENT FLOW STOPS.

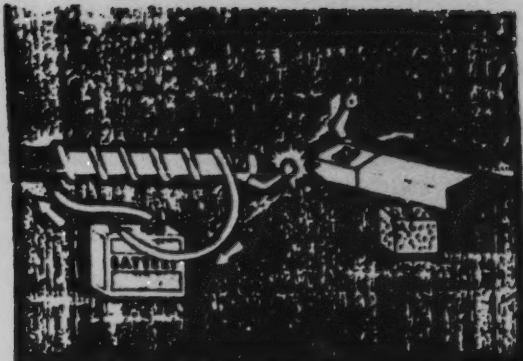


- C. POLES OF ELECTROMAGNET CAN BE REVERSED BY CHANGING THE WIRE CONNECTIONS.

- D. ALTERNATING CURRENT CHANGES ON ITS OWN.

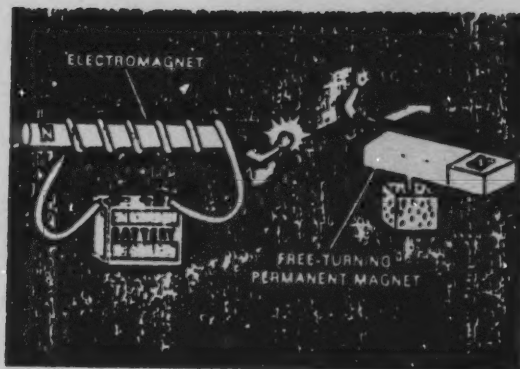
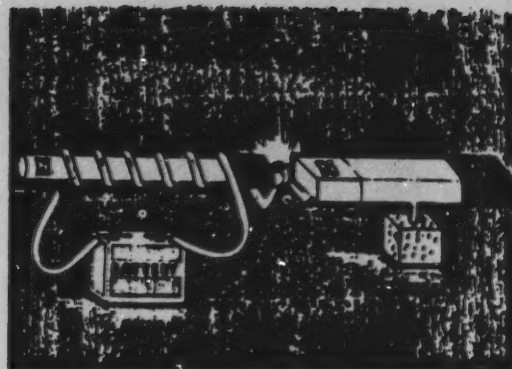


OPERATION OF AN ELECTROMAGNET



A. LIKE POLES REPEL EACH OTHER.

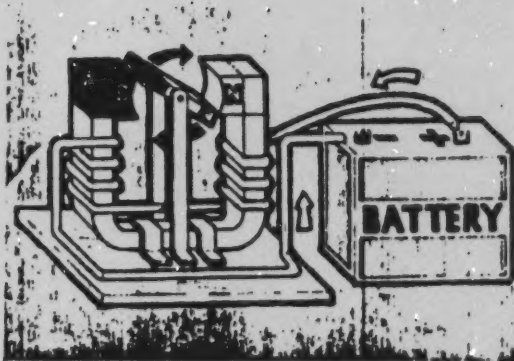
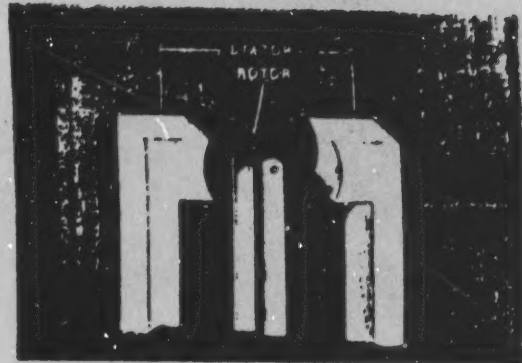
B. UNLIKE POLES ATTRACT EACH OTHER.



C. CHANGING WIRE CONNECTIONS CHANGES THE DIRECTION OF CURRENT FLOW. THIS CAUSES ROTATION OF THE FREE-TURNING MAGNET.

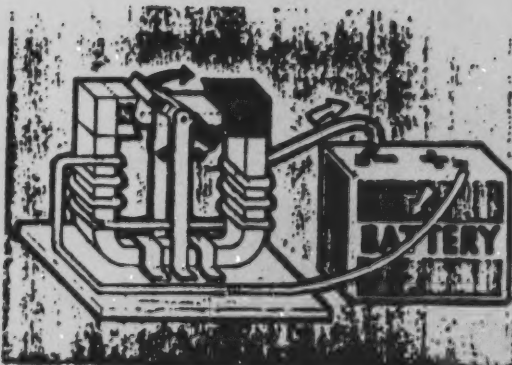
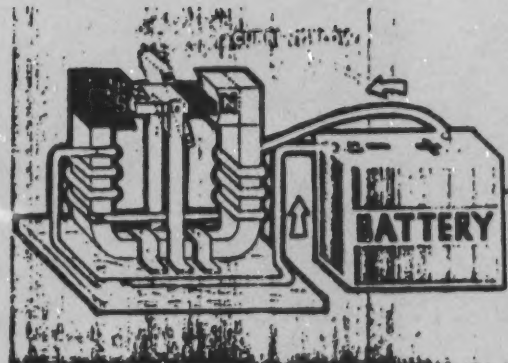
BASIC OPERATION OF AN ELECTRIC MOTOR

- A. STATIONARY ELECTROMAGNET IS THE "STATOR," THE ROTATING MAGNET IS CALLED TO ROTOR.



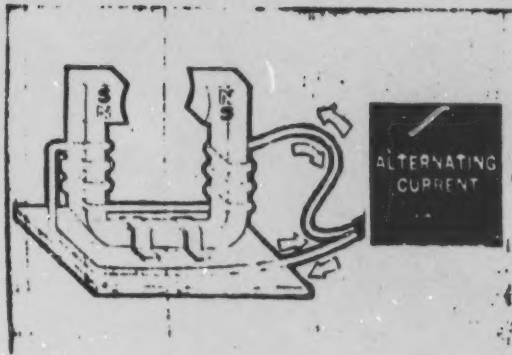
- B. LIKE POLES TOGETHER CAUSE THE MAGNET TO ROTATE.

- C. THIS ROTATION IS ONE-HALF TURN.



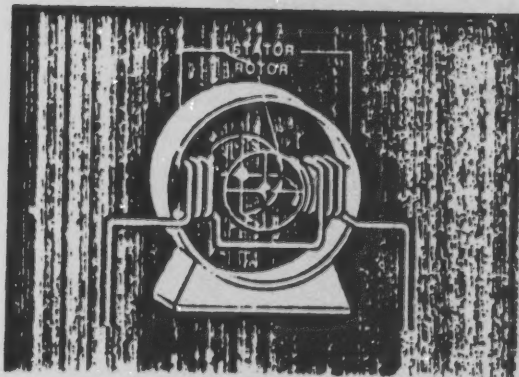
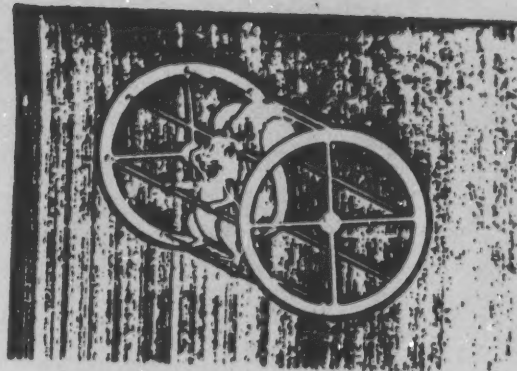
- D. CHANGING DIRECTION OF CURRENT FLOW CAUSES THE ROTATING MAGNET TO GO ANOTHER HALF TURN.

BASIC OPERATION OF AN ELECTRIC MOTOR



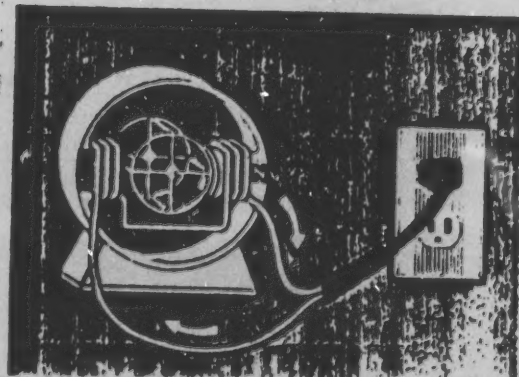
A. REVERSING DIRECTION OF CURRENT FLOW
CHANGES POLARITY OF STATOR.

B. ROTOR IS CALLED A SQUIRREL-
CAGE ROTOR.

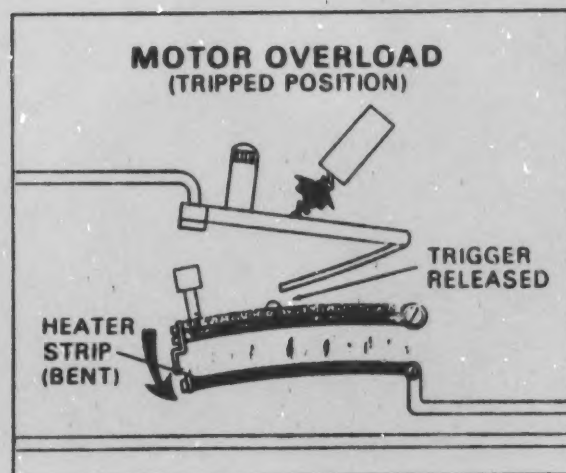
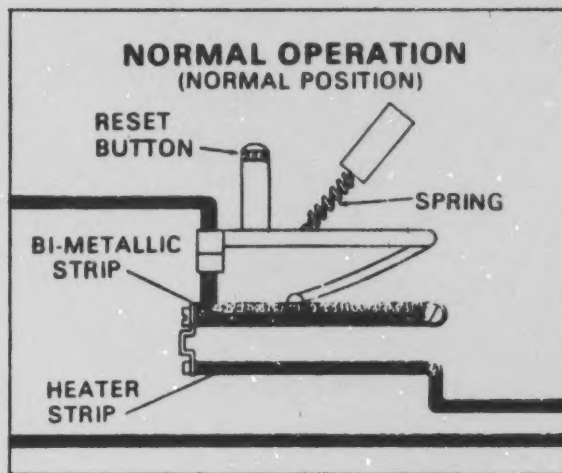


C. ROUND FRAMES SURROUND AND HOLD THE
ROTOR AND STATOR.

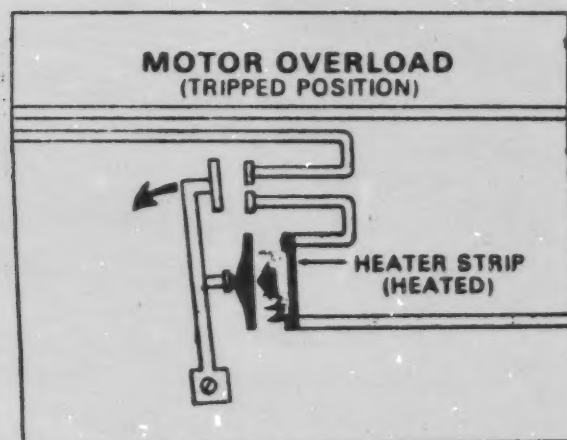
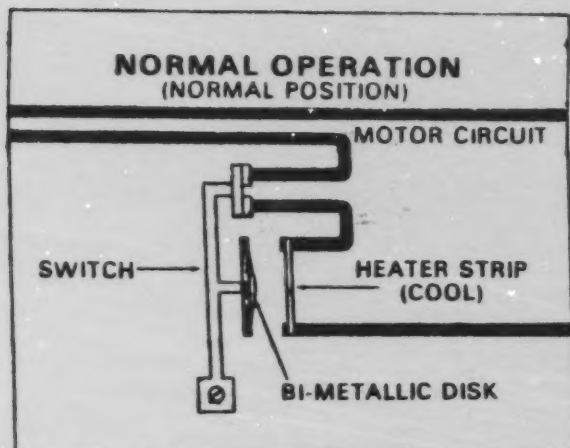
D. WITH ALTERNATING CURRENT,
CURRENT FLOWS FIRST IN ONE
DIRECTION, THEN ANOTHER.



MANUAL RESET OVERLOAD PROTECTION

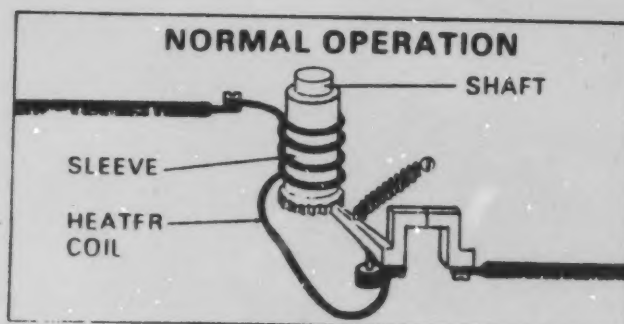
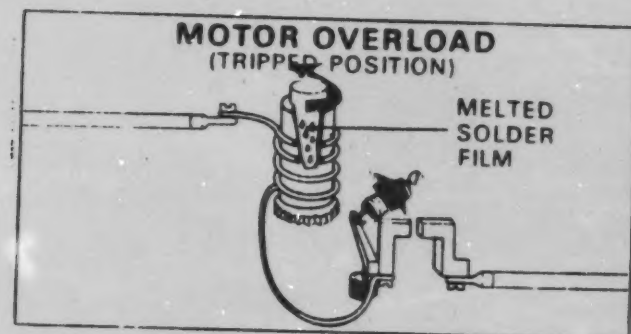
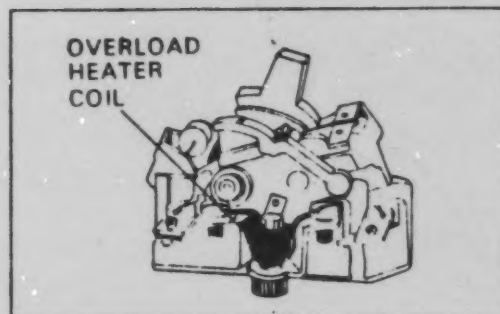


AUTOMATIC RESET OVERLOAD PROTECTION



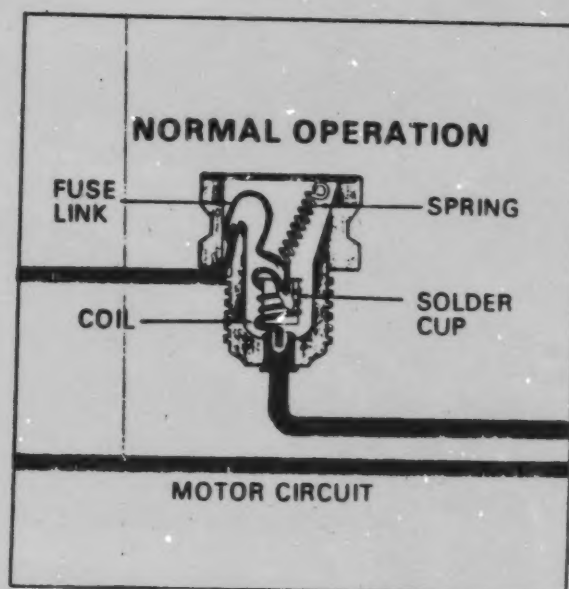
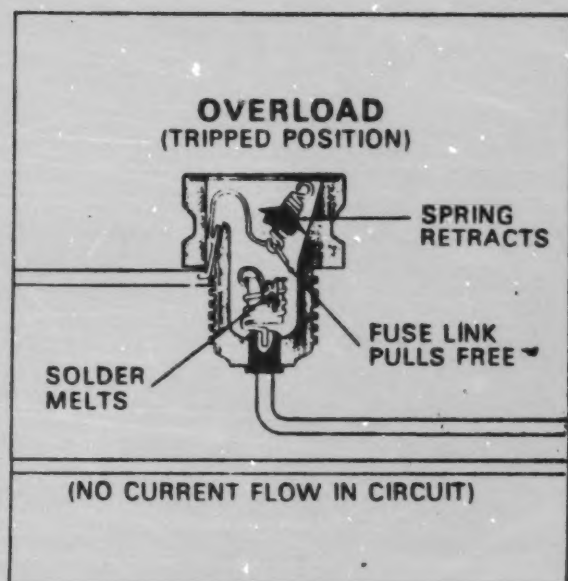
TRANSPARENCY IV-4-F

MANUAL STARTING SWITCH WITH OVERLOAD PROTECTION



TRANSPARENCY IV-4-G

TIME-DELAY FUSE

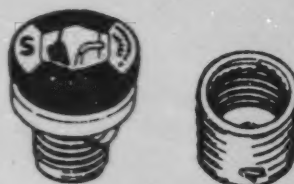


TYPES OF TIME-DELAY FUSES

**STANDARD
PLUG-FUSE**



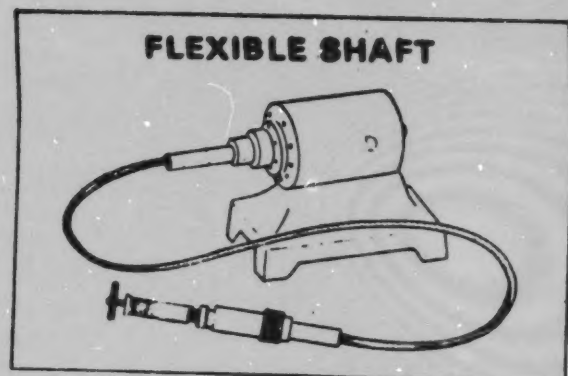
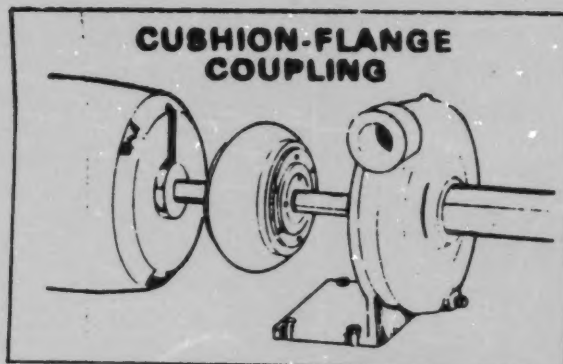
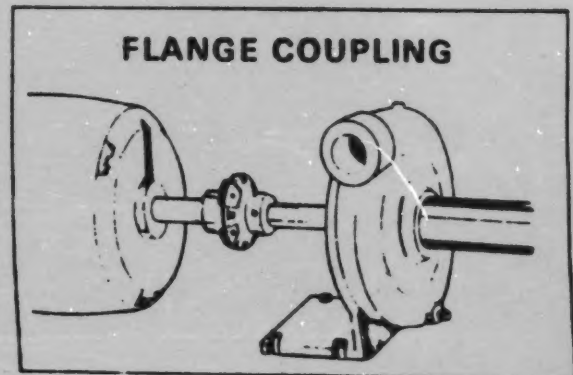
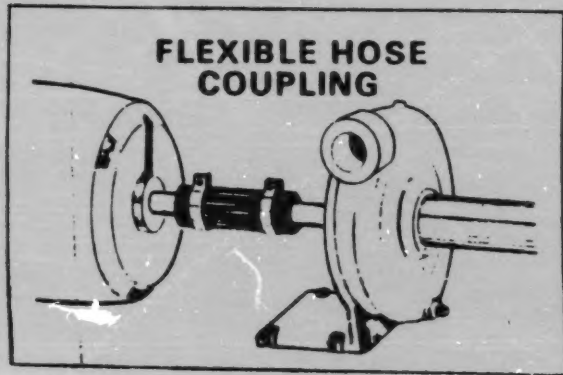
**ADAPTER FUSE
& ADAPTER**



**CARTRIDGE
FUSE**



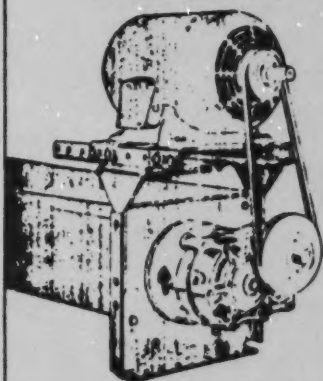
TYPES OF DIRECT MOTOR DRIVES



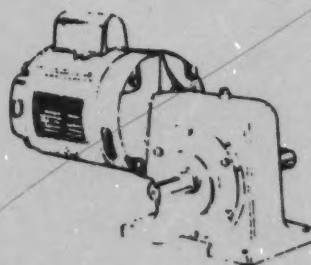
TRANSPARENCY IV-4-J

TYPES OF SPEED CONVERSION DRIVES

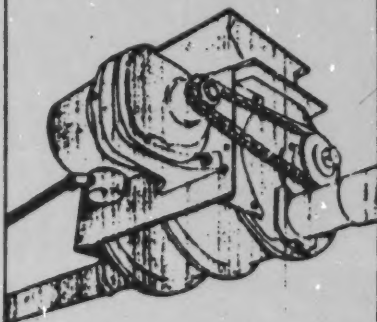
**PULLEY-AND-
BELT DRIVE**



GEAR DRIVE

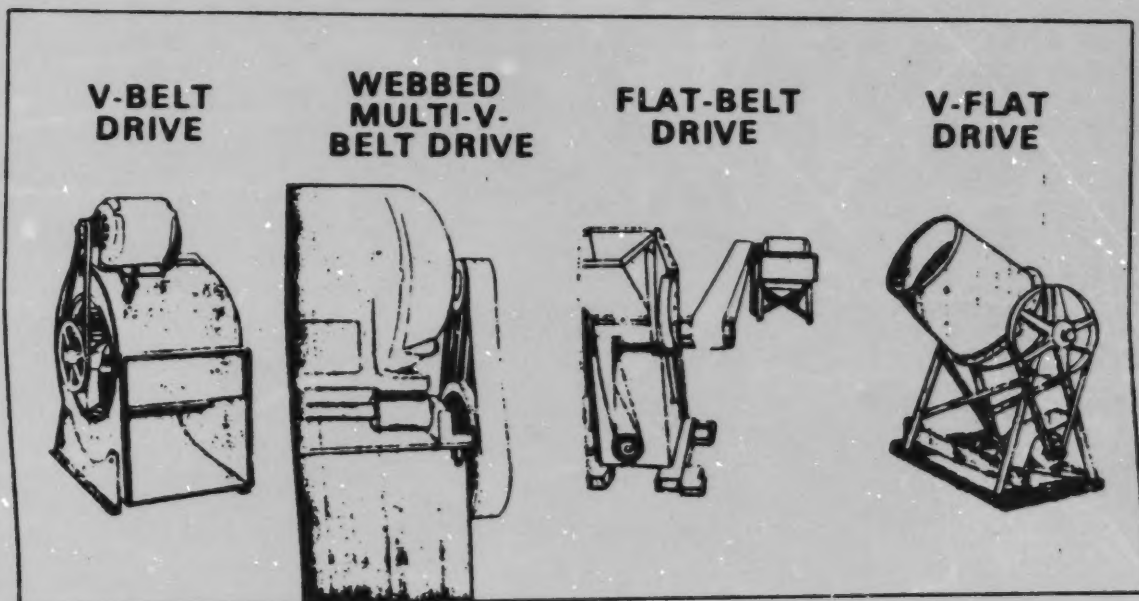


**CHAIN-AND-
SPROCKET DRIVE**



TRANSPARENCY IV-4-K

TYPES OF PULLEY AND BELT DRIVES



TRANSPARENCY IV-4-L

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 5: Maintaining Electric Motors

I. Preparation for Instruction

A. Objectives

1. Terminal: Demonstrate maintenance procedures for electric motors.
2. Specific:
 - a. Demonstrate the procedures for proper lubrication of electric motors.
 - b. Demonstrate the process of cleaning an electric motor.
 - c. Describe the procedures for general maintenance of an electric motor.

B. Review of Teaching Materials

1. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishers, 1977.
2. Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York: The MacMillan Company, 1960.

C. Special Arrangements

1. Obtain enough electric motors for each pair of students to be assigned in the class for the suggested student activities.
2. Obtain tools necessary for disassembly and assembly of the electric motors.

II. Presentation of the Lesson

A. Motivation

1. Demonstrate the consequences that occur when a motor is operated that was not cleaned and lacked proper maintenance.
2. Show the interior of an electric motor that has been ruined by operating it in an unmaintained state.

B. Content Outline

1. Lubrication

- a. Many motors today have bearings that require no lubrication. However, most do require some oiling procedure for proper maintenance. Most manufacturers give lubrication information with the motor when purchased. It is most important to follow the recommended instructions as to grade, weight, and amount of lubricant described.
- b. Do not overlubricate since this creates overheating from an accumulation of grease and dirt. This will tend to overload the motor and wear out bearings. It is helpful to maintain up-to-date and accurate records showing lubrication dates for various motors.
- c. It is essential to stop the motor and clean the area around the cover or plug of the lubrication system. Old oil should be drained every 18 months. Clean oil and clean containers should always be used in the oiling process.

2. Cleaning the Motor

- a. The exterior of the motor can be cleaned with a dry cloth. This removal of dirt and lint can prevent internal damage to the motor. Ventilation openings should be checked and cleaned regularly. In addition, a clean exterior will help maintain cooler motor operation.
- b. It is usually necessary to clean the internal parts of the motor every three to four years. Disassembly of the motor is required for proper cleaning of this type.
- c. The form bolts holding the end shields are removed first. Remove the end shields with a tap of a hammer or by prying gently with a screwdriver. When the shields are removed, check all wires for damage and proper placement. The rotor should easily slide out after the end shields are removed.
- d. Cleaning is recommended as follows:
 - 1) Clean rotor and oil from the windings with carbon tetrachloride.
 - 2) Clean switch contacts with sandpaper.
 - 3) Clean the windings using compressed air.

- 4) Clean oil from all exposed surfaces.
- 5) Inspect bearings for smoothness.
- 6) Clean lubrication system if bearings show evidence of being scratched.
- 7) Reassemble after cleaning.

3. General maintenance procedures

- a. Oil regularly and use only a few drops.
- b. Keep the motor clean.
- c. Check unsealed bearings at least once a year and keep housing filled to the proper level with ball bearing grease.
- d. Clean commutator with 00 sandpaper while the motor is running. Do not use emery cloth.
- e. Do not allow motor to run hot.
- f. Use a cable on the motor of sufficient size to carry the power needed.
- g. Clean dust and dirt from the motor. A vacuum cleaner can be used to clean the windings.
- h. Do not overload the motor.
- i. Always keep belt tension properly adjusted.
- j. Keep the motor properly aligned with the equipment being driven.

C. Suggested Student Activities

1. Each student will design and construct a poster board display that illustrates the importance of maintenance and cleaning.
2. Divide students into pairs. Each pair of students will be assigned an electric motor. The students will disassemble the motor, properly clean it, and reassemble for operation.

INSTRUCTIONAL AREA: Agriculture Mechanics

INSTRUCTIONAL UNIT V: Tractor Maintenance, Operation, and Safety

LESSON 1: Tractor Safety

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Demonstrate correct and safe tractor operating habits.
2. Specific:
 - a. Demonstrate good safety habits.
 - b. Use proper hand signals for communications.
 - c. Recite safety rules from memory.
 - d. Demonstrate proper use of slow moving vehicle emblem.
 - e. Demonstrate accepted safety practices when using hitch mounted equipment.
 - f. Demonstrate proper safety procedures when using equipment that is pulled behind the tractor.

B. Review of Teaching Materials

1. Fundamentals of Machine Operation: Tractors. Moline, Ill.: Deere and Company, 1974.
2. Tractor Operation and Daily Care. Athens, Ga.: American Association for Vocational Instructional Materials, 1967.

C. Special Arrangements

1. Farm Bureau Tractor Safety Program (slides and movies)
2. National Farm Safety Foundation (brochures)

II. Presentation of Lesson

A. Motivation

1. Slide and movie presentation by the safety department of the Louisiana Farm Bureau Federation
2. Newspaper accounts of local farm accidents

B. Content Outline

One of the most important aspects of tractor operation is establishing good safety practices. Because tractors are large, heavy, and powerful machines, they require careful operation and service. New tractors are equipped with safety devices to provide a reasonable amount of protection. However, it is the operator's responsibility to practice good safety habits. A good tractor operator must always be alert for situations that are potentially dangerous.

Often, when operating the tractor, people must communicate with the operator. The sound of the tractor normally prevents effective vocal communication. The most effective kind of communication in this situation is the use of hand signals understood by the operator and the person with whom he is communicating. Several organizations and safety organizations have endorsed a set of universal signals. Learn these signals and use them to prevent accidents.

Before operating a tractor, study the operator's manual. The more the operator knows about a tractor, the better prepared he will be to operate it safely. If a tractor is stored inside a building, open the doors to provide adequate ventilation. Do not operate a tractor in an enclosed building for long periods of time, the engine exhaust fumes are very poisonous.

There are a series of preoperation safety checks. These include the following:

1. Clean the tractor before starting. Trash around the exhaust system can catch fire. Oil and grease on ladders can cause the operator to slip or fall. If the tractor is equipped with a cab, clean the windows.
2. Check the tire inflation pressure. Underinflation can cause the side walls of the tire to buckle. Over inflated tires tend to bounce and can cause upsets more rapidly than tires with the proper pressure.
3. Check the operation of all control lights and gauges to see that they are working properly.
4. Make sure that all shields and covers are in place and securely fastened.
5. Do not attempt to climb onto the tractor by any other means than the steps and handrails.
6. Adjust the seat so that all controls are within easy reach.

Care when starting a tractor is essential to avoid injury to the operator and others. Follow these safety practices when starting a tractor:

1. Make sure that everyone is clear of the machine.
2. Allow no one on the tractor except the operator.
3. Before starting the engine:
 - a. Place all hydraulic controls in neutral,
 - b. Disengage the PTO,
 - c. Apply the brakes,
 - d. Place gearshift in neutral or park, and
 - e. Depress the clutch pedal.
4. Be careful when using starting fluid. It is extremely flammable.
5. If necessary to use jumper cables, avoid sparks around the battery. Hydrogen gas may be present and is explosive.

Stopping a tractor safely involves more than just applying the brakes and turning off the engine. Use the following safety suggestions to avoid accidents.

1. Always slow down before applying brakes.
2. Disengage the PTO.
3. Lower all hydraulically powered equipment to the ground.
4. Place the gearshift lever in park or lock the brakes.
5. Turn the ignition key to the off position and remove it to prevent accidental starting.

Operating the tractor safely is important. Follow these guidelines for proper operation safety:

1. Operate the tractor only when alert or rested.
2. Allow only qualified persons to operate the tractor.
3. Wear safety glasses if the tractor does not have a cab.
4. Wear snug fitting clothing to avoid catching clothing on moving parts.

5. Never allow anyone but the operator on the tractor.
6. Use seat belts when the tractor is equipped with ROPS (roll over protection structure).
7. Always sit down when operating the tractor; a sudden jolt can throw you off the platform.
8. When operating with mounted equipment, always use adequate weighting for tractor stability.
9. When operating on slopes, avoid sharp turns, especially when turning uphill.
10. When turning, slow down and begin the turn before applying the brake to assist in turning.
11. When attempting to operate the tractor on a steep slope, back the tractor up the hill to avoid overturning.
12. Do not get near the edge of a ditch or gully.
13. Hitch loads to the drawbar to help prevent backward overturns.
14. Lower an implement to the ground when not in use.
15. Keep all shields in place.
16. Use the tractor only for jobs for which it was intended.

Often it is necessary to make repairs or adjustments or perform maintenance in the field. When this is necessary follow the following safety precautions:

1. Disengage the PTO.
2. Lower all raised equipment at the ground.
3. Shut off the engine.
4. If necessary to work underneath the equipment, use safety supports. Do not rely on the hydraulic system to support the implement.
5. Never smoke when refueling a tractor.
6. Do not check the coolant level until the engine has cooled down.
7. Make sure that all pressure has been relieved before disconnecting hydraulic lines.

8. Make sure that all shields or guards are replaced if removed for repairs or adjustments.

C. Suggested Student Activities

1. Have students demonstrate the safe way to operate a tractor.
2. Have students observe tractor operation habits of family members or friends and report back to class on violations of safety practices.

D. Study Questions

1. Demonstrate the proper use of hand signals.
2. Demonstrate the proper safe way to start a tractor.
3. Demonstrate the proper safe way to operate a tractor on a slope.
4. Demonstrate the proper techniques to use when servicing a tractor in the field.
5. Explain how many riders are allowed on a tractor and why.
6. Explain why and when a seat belt should be used on a tractor.
7. Explain why the tractor operator should remain seated while operating the tractor.

INSTRUCTIONAL AREA: Agriculture Mechanics

INSTRUCTIONAL UNIT V: Tractor Maintenance, Operation, and Safety

LESSON 2: Tractor Maintenance

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Maintain tractors properly.
2. Specific:
 - a. Maintain tractor cooling systems.
 - b. Maintain lubricating system.
 - c. Service air cleaning assembly.
 - d. Service fuel system.
 - e. Service ignition system.
 - f. Maintain power trains.
 - g. Service braking system.
 - h. Service hydraulic system.
 - i. Maintain steering system.
 - j. Service tires.

B. Review of Teaching Materials

1. Fundamentals of Machine Operation: Preventive Maintenance. Moline, Ill.: Deere and Company, 1973.
2. Fundamentals of Machine Operation: Tractors. Moline Ill.: Deere and Company, 1973.
3. Tractor Maintenance Principles and Practices. Athens, Ga.: American Association for Vocational Instructional Materials, 1970.

C. Special Arrangements

1. A visit to the local tractor company's service department
2. Samples of parts of a tractor damaged because of improper maintenance practices
3. Cost figures for replacement of damaged parts worn out because of negligence.

II. Presentation of the Lesson

A. Motivation

Use prices of new equipment with labor, and parts cost estimates from actual repair jobs at tractor dealers to illustrate the need for proper maintenance practices of farm equipment.

B. Content Outline

1. The importance of tractor maintenance:

- a. Properly maintained tractors will give long life and satisfactory service.
- b. Proper daily care is essential for a tractor to give long service.
- c. The operators manual is the best guide to follow for a good maintenance program. This manual explains what parts need service and at what intervals they should be serviced.

2. Operation devices which protect the tractor: (Transparency V-2-A)

- a. Heat indicator -- This device indicates the temperature of the liquid in the cooling system.
- b. Oil pressure gauge -- This light or dial gauge indicates the pressure which is being regulated by the circulation of the oil.
- c. Ammeter -- This light or dial indicator tells whether or not the proper amount of current is flowing from the battery.
- d. Tachometer -- This gauge tells how fast the engine is running in revolutions per minute (rpms).
- e. Hour meter -- This indicates the number of hours of use and serves as a reminder to the operator (who maintains services needed to be performed).

3. Special Care Practices

Under certain operating conditions, maintenance services should be performed more often than is usually necessary. These conditions include operating in mud, water, or extremely dusty conditions.

4. Daily Care Practices

- a. After 10 hours of operation, the tractor should be maintained by performing the following service procedures:
 - 1) Check crankcase oil level,
 - 2) Lubricate grease fittings,
 - 3) Clean air filter,

- 4) Check coolant level in radiator,
 - 5) Check tire pressure,
 - 6) Check fuel level,
 - 7) Check for broken or worn parts, loose nuts, and bent brackets, and
 - 8) Check the fan, generator, and water pump belts.
- b. After 50 hours of operation, the tractor should be maintained by performing the following service procedures:
- 1) Check fan shaft bearings and water pump bearings for lubrication,
 - 2) Check crankcase oil, drain, and refill,
 - 3) Check hydraulic fluid filter and replace if needed,
 - 4) Check tires for proper pressure,
 - 5) Check radiator core, all belts,
 - 6) Check flexible rubber connections for loose fitting or leakage,
 - 7) Check and torque cylinder head bolts on LP engines,
 - 8) Check fluid level in battery,
 - 9) Check and lubricate clutch release mechanism, and
 - 10) Check and service dry type of air filter element.
- c. After 100 hours of operation, the tractor should be maintained by performing the following service procedures:
- 1) Change oil and filter,
 - 2) Check and lubricate brake pedals, clutch pedal, and clutch release bearing,
 - 3) Check valve clearance,
 - 4) Check and torque cylinder head bolts, and

- 5) Check and clean cylinder head and crankcase breather.
- d. After 250 hours of operation, the tractor should be maintained by performing the following service procedures:
 - 1) Check, drain, and refill crankcase and oil filter,
 - 2) Check and clean fuel sediment bowl,
 - 3) Check and clean hydraulic screen and replace filter,
 - 4) Check and lubricate all points on tractor,
 - 5) Check and adjust brakes and clutch, and
 - 6) Check and adjust spark plugs and points on gasoline and LP engines.
- e. After 500 hours of operation, the tractor should be maintained by performing the following service procedures:
 - 1) Check and repack front wheel bearings,
 - 2) Check hydraulic system and change oil,
 - 3) Check steering gear housing and change oil,
 - 4) Check cooling system, drain, and refill, and
 - 5) Check timing of the tractor.
- f. After 1000 hours of operation, the tractor should be maintained by performing the following service procedures:
 - 1) Check transmission, differential, and final drive. Drain and refill these parts.
 - 2) Check all other parts and make adjustments.
5. Results of inadequate maintenance:
 - a. Dirty air cleaners,
 - b. Dirty crankcase breathers,
 - c. Low tire pressure,

- d. Low liquid level in battery,
 - e. Improper valve adjustment,
 - f. Pitted ignition points,
 - g. Spark plugs dirty and out of adjustment,
 - h. Dirty crankcase oil,
 - i. Liquid low in radiator,
 - j. Prakes out of adjustment,
 - k. Dirty fuel pump sediment bowl,
 - l. Bearings lacking lubrication,
 - m. Hydraulic fluid level low, and
 - n. Loose V-belts,
6. Servicing air cleaners, dry and oil bath types
(Transparency V-2-B)
- a. Oil bath type air cleaner service procedures
(Transparency V-2-C)
 - 1) Stop engine before air cleaner is serviced.
 - 2) Remove the oil cup and clean thoroughly, then refill with oil to proper level.
 - 3) Inspect the screen for chaff and other foreign matter; remove this before replacing oil cup.
 - 4) The entire air cleaner should be removed once per year and thoroughly cleaned with kerosene or fuel oil.
 - b. Dry type air cleaner service procedures
(Transparencies V-2-D and V-2-E)
 - 1) Stop the engine before servicing the cleaner.
 - 2) If the air cleaner is equipped with an unloader valve for dust, open this to release dust. If the unloader is damaged, replace it.
 - 3) Use a clean rag to clean the area around the element before the element is removed.
 - 4) If the rubber gasket on the end of the filter is damaged, the entire filter must be replaced.

5) If the element is not to be replaced, clean it by using the following procedure:

- a) Tap the element to loosen the dirt. Shake the element to remove the loose dirt.
- b) Use a compressed air hose to blow the element clean.
- c) Wash the element with detergent and water. Rinse with clean water and allow 24 hours for drying before replacing the element.

7. Lubricating the tractor and crankcase

a. Types of engine lubricating systems:

- 1) Splash -- Oil is splashed to the working parts of the engine by cups, dippers, or troughs in the engine, and is used in single cylinder engines.
- 2) Circulating-splash -- Oils are splashed to parts of the engine by the end of the connecting rods as they revolve through the splash pan troughs. Oil is supplied to the troughs by an oil pump located in the crankcase. (Transparency V-2-F)
- 3) Force-feed -- An oil pump picks up oil and forces it to the various parts of the engine. (Transparencies V-2-G and V-2-H)

b. Changing crankcase oil -- This should be done while the engine is warm. It is important to remove the oil immediately after stopping the engine. More of the dirt, sludge, and other contaminants are removed if they are not given the chance to settle. (Transparency V-2-I)

c. Factors influencing the changing of oil:

- 1) Length of running period between changes
- 2) Long idle periods of tractor
- 3) Running the tractor on short trips during cold weather
- 4) Using the tractor on dirty or dusty jobs
- 5) Metal and other abrasives collected in crankcase

d. Greasing the tractor

- 1) The operator's manual is used to determine when to grease the tractor. Tractors that work under moist or dusty conditions need greasing more frequently.
- 2) It is important to use the correct type and amount of grease. Some working parts are enclosed in a rubber container that may be damaged if too much grease is used.
- 3) All grease fittings must be wiped clean before applying grease with the grease gun. Grease must be free from impurities. Dust particles can destroy a bearing in a short time.

8. Servicing the cooling system of the tractor
(Transparency V-2-J)

- a. The radiator should be checked for the following conditions:
 - 1) Bend or damaged fins,
 - 2) Dents on frame or tanks,
 - 3) Cracked tubes or solder seams, and
 - 4) Clogged or bent overflow tube.
- b. Defective caps should be replaced.
- c. Check fan for bent blades and closeness of blades to the radiator core. (Transparency V-2-K)
- d. Check fan belts for wear and proper tension adjustment.
 - 1) Belts that are too tight cause excessive bearing wear.
 - 2) Belts that are too loose may cause engine overheating and excessive belt wear.
- e. Check water pump for leaks or damaged housing.
- f. Hoses can be checked by squeezing to see if they are cracked, hard, or brittle. They should not be soft or swollen. (Transparency V-2-L)
- g. Keeping the cooling system filled with proper coolant is necessary. Use the following procedures.

- 1) Drain system; flush with clean water. Use a cleaning agent if corrosion or rust exists.
- 2) Checks for leaks and tighten all connections.
- 3) Refill with water and an approved coolant.

9. Maintaining the fuel supply system

- a. In order for a fuel supply system to give good performance, it is necessary that all parts of the system remain in proper working condition. (Transparency V-2-M)
- b. Fuel filters are used to stop water and foreign objects before they reach the fuel pump. They should be checked periodically and drained. If the filter is equipped with a screen or sediment bowl, they should be removed and cleaned. Any part that is damaged or cannot be cleaned should be replaced.
- c. Carburetors should be checked and adjusted after each 250 hours of operation. The following steps should be followed when servicing a carburetor.
 - 1) Clean all metal parts with a cleaning solution.
 - 2) Avoid the use of wires or drill bits when cleaning orifices or jets.
 - 3) Adjust needles properly. The needle seat may be damaged if they are seated too tight.
 - 4) Test the float for leaks and check its height.
 - 5) Tighten all screws, especially those which hold the throttle dish in place.
 - 6) Adjust idle fuel mixture by turning in until the engine begins to idle roughly; then it is turned out until the engine idles smoothly.
 - 7) Adjust full-load fuel mixture by turning the screw in until the engine loses power; then is backed out until the engines run smoothly.
- d. Diesel fuel systems are equipped with fuel filters to protect the fuel injection system and engine from the finest particles of abrasive sediment and dirt. If a diesel engine begins to miss, the first place to check is the fuel filtering system. The diesel system does not have a carburetor; it is equipped with a fuel pump and filter system similar to those of gasoline engines. (Transparency V-2-N)

10. Maintenance of a tractor ignition system

a. Battery maintenance (Transparency V-2-0)

- 1) Clean with damp cloth or brush using baking soda and water solution to neutralize acid deposits.
- 2) Inspect and tighten all battery connections.
- 3) Remove and clean corroded cables.
- 4) Clean terminal posts with a steel brush.
- 5) Apply grease to post and cable connection to slow down future corrosion.
- 6) Keep cells filled to proper level by adding clean water.

b. Servicing ignition switch and ammeter

- 1) Replace these if they do not function properly.
- 2) Check wires leading to switch and ammeter if problems arise with these units.

c. Ignition coil service (Transparency V-2-P)

- 1) Check terminals and connections to make sure they are clean and tight.
- 2) Rubber nipples and boots should be in good condition. Damaged rubber pieces on high voltage circuits will cause leakage of current where surfaces are exposed.
- 3) Cracked coils must be replaced.
- 4) Coils with bad wiring must be replaced.

d. Distributors are usually checked if the engine is hard to start, fires improperly, or if the engine uses excessive amounts of gasoline (Transparency V-2-Q)

- 1) Replace damaged distributor cap,
- 2) Replace rotor if it is badly burned, worn, or has a weak contact spring,
- 3) Breaker points should be filed smooth if pitted; replace if pitted badly, and

- 4) Set breaker point gap as recommended, grease the cam, and oil the felt pad. (Transparency V-2-R)
- e. Spark plug wires should be checked periodically.
 - 1) Inspect for mechanical wear and defective insulation.
 - 2) A manual method of testing plug wires is to remove the wire from the plug and hold it $\frac{1}{4}$ inch away from the engine. If a spark occurs while the engine is turning, the distributor and wires should be functioning properly.
- f. Spark plugs should last about 250 hours under normal engine use. They should be checked every two or three months. Clean and regap plugs when needed.

11. Maintenance and service of the tractor power train

- a. Clutch service should be done according to the operator's manual. Service procedures include the following: (Transparency V-2-T)
 - 1) Checking clutch pedal free travel which should be between $\frac{1}{2}$ and $2\frac{1}{2}$ inches. This is the distance the pedal travels from its stationary position until it meets resistance. Adjustment locations are usually found on the throw-out rod, adjusting stud on the housing, and at the base of the pedal.
 - 2) Wet types of clutches should be checked for oil level, oil seal condition, and oil circulation.
 - 3) To reduce clutch wear, always remove the foot from the clutch pedal while driving the tractor.
- b. Transmission, differential, and final drive maintenance (Transparency V-2-U)

Lubrication is the major maintenance procedure. Gear teeth and bearings must be protected at all times with a constant supply of clean lubricant to prevent wear. Maintenance practices are as follows:

- 1) Clean the area where the oil level is and check to avoid entry of dirt into gear case.
- 2) Drain lubricant from each compartment of the gear case. This should be done after a period of operation so that warm oil will assure complete drainage.

- 3) Replace gear case lubricant with the proper type of oil as recommended in the operator's manual.
- 4) If the tractor has a gear case filter, change it when replacing lubricant.
- 5) Check air breathers to make sure they are not clogged. Clean or replace if they are clogged.
- 6) Check for leaks and replace seals or gaskets or tighten bolts around gaskets.

12. Servicing and maintaining tractor brakes (Transparency V-2-V)

- a. Adjusting brakes on tractors is usually done by shortening the linkage between the brake and pedal or by making the star wheel adjusting screw longer. The brake is tightened until there is a certain amount of free travel on the brake pedal. This free travel distance is specified in the operator's manual.
- b. Adjusting brakes is a job more easily done if the two rear wheels are held above the ground by a hoist or jack stands. (Transparency V-2-W)
- c. To check for equalization of the brakes use the following steps.
 - 1) Latch the two brakes together.
 - 2) Start the engine and start the wheels turning by shifting into gear.
 - 3) Shift back into neutral and apply pressure to the brake pedal. The wheels should brake evenly if they are properly adjusted.
 - 4) Lower the tractor to the ground and check the brakes by driving and stopping.

13. Maintaining the hydraulic system

- a. Two major points to remember in servicing hydraulics:
 - 1) Proper operation, and
 - 2) Use of a good grade of clean oil.
- b. Damage to hydraulic systems are caused by:

- 1) Dirty oil,
- 2) Use of the wrong type of oil,
- 3) Low oil level,
- 4) Loose lines,
- 5) Clogged or dirty filters,
- 6) Too much pressure in the system,
- 7) Too much heat in the system, and
- 8) Operating the system too fast.

c. Important maintenance practices to use are as follows: (Transparency V-2-X)

- 1) Store new oil in clean location and use clean funnels and containers with fine mesh screen when adding fluid to system.
- 2) Any connection on the system that would allow dirt or other contaminants to enter the oil should be wiped clean before removing.
- 3) Check for internal and external leaks. The symptom for internal leaks is sluggish action. External leaks can be easily detected and corrected.
- 4) Drain and flush system as recommended by the operator's manual. Flushing each time the oil is changed is usually not necessary.
- 5) After refilling the system with new oil, operate 4 or 5 times through a complete cycle before bleeding air from the system.
- 6) Avoid overheating of the oil. This breaks down the oil, causes varnish deposits and reduces efficiency of the unit. To prevent overheating:
 - a) Keep oil at proper level in reservoir,
 - b) Keep lines, reservoir, and cooler free from dirt and materials that reduce oil flow or contaminate the oil, and
 - c) Keep relief valves operating properly.

14. Tractor steering maintenance

a. Maintenance of manual steering systems:
(Transparency V-2-Y)

- 1) Check the gear box every 6 months or as recommended by the operator's manual. Add oil to the proper level. If the steering case is equipped with a grease fitting, add multipurpose grease.
- 2) If there is a vent plug on top of the housing, keep it open to relieve pressure caused by heat.
- 3) Adjust gears, worm shaft end play, and sector shaft end play according to the operator's manual.
- 4) Lubricate tie rod ends, axle pivots, kingpins, and steering knuckles after each 10 hours of operation. (Transparency V-2-Z)

b. Maintaining power steering systems:

- 1) Check oil level and add oil when needed.
- 2) Correct leaks around fittings, hose clamps, and line connections.
- 3) Bleed air in the system by either draining and refilling or operating the system several cycles free of load. Air in lines causes poor lubrication.
- 4) Drain and refill the power system as recommended by the operator's manual. The steps for draining and refilling are as follows:
 - a) Clean around the work area on the system.
 - b) Remove drain plug or disconnect a lower hose and drain fluid. Replace drain plug in hose.
 - c) Replace filter if one is present.
 - d) Refill reservoir to full mark on dipstick.
 - e) Start engine and turn steering wheel several complete turns.
 - f) Stop engine and add fluid if needed.
- 5) Lubricate the lower pedestal bearing, tie rod ends, axle pivots, steering knuckles, and kingpins every 10 hours of operation.

15. Maintaining and servicing tractor tires:

Maintenance practices that may prolong the life of a tire include the following:

- a. Check tire pressure daily to avoid operating the tractor with overinflated or underinflated tires. (Transparencies V-2-AA, V-2-BB, and V-2-CC)
- b. Adjust inflation pressures for special conditions. Add 4 extra pounds to the rear furrow wheel when plowing.
- c. Check front wheels for correct alignment.
- d. Avoid tire bruises. Wet rubber is easier to bruise or cut than dry rubber.
- e. Operate tractor at slow rate of speed on hard-surfaced roads if they are liquid filled.
- f. Remove wheel weights from tractor if it is to be stored for several weeks.
- g. Park tractor in dry clean area to protect tires from oil, grease, and moisture which tends to damage tires.
- h. Wash tires after spraying or distributing fertilizer if tires come in contact with these chemicals.
- i. When replacing tire on rim, do not use soap or grease on the bead; these materials can cause the tire to slip under heavy drawbar pull.
- j. If the tractor is to be stored for several months, jack it up to protect tires; storage under a shed will protect rubber tires from direct sunlight.
- k. Inflate the tires to maximum pressure when driving a long distance on hard-surface roads.
- l. Test valve stems periodically and replace those that are leaking. Replace valve caps if the rubber washer inside the cap shows wear.
- m. Check the tires for cuts, breaks, and bruises. Cuts and breaks may be repaired with tire gum or tire dough. Inside breaks can be repaired with a boot or vulcanized patch. If cuts are repaired immediately the cords will last longer; if moisture enters the cut, it tends to rot the cord fibers.

- n. Protect the liquid against freezing in a tire by adding calcium chloride to the water. Freezing will cause inside breaks of the tire cord.

C. Suggested Student Activities

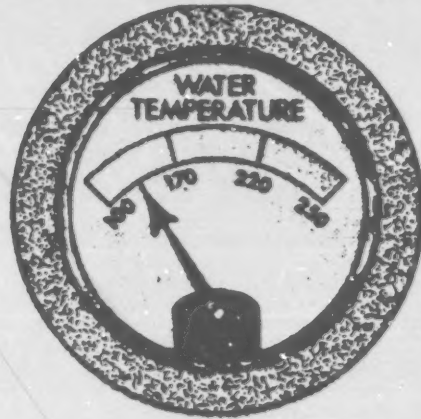
1. Have students demonstrate skills in each of the areas of tractor maintenance.
2. Have students check on their own farm to see which maintenance practices have been neglected.

GAUGES TO AID IN OPERATION

AMPERES GAUGE



WATER TEMPERATURE GAUGE



OIL PRESSURE GAUGE



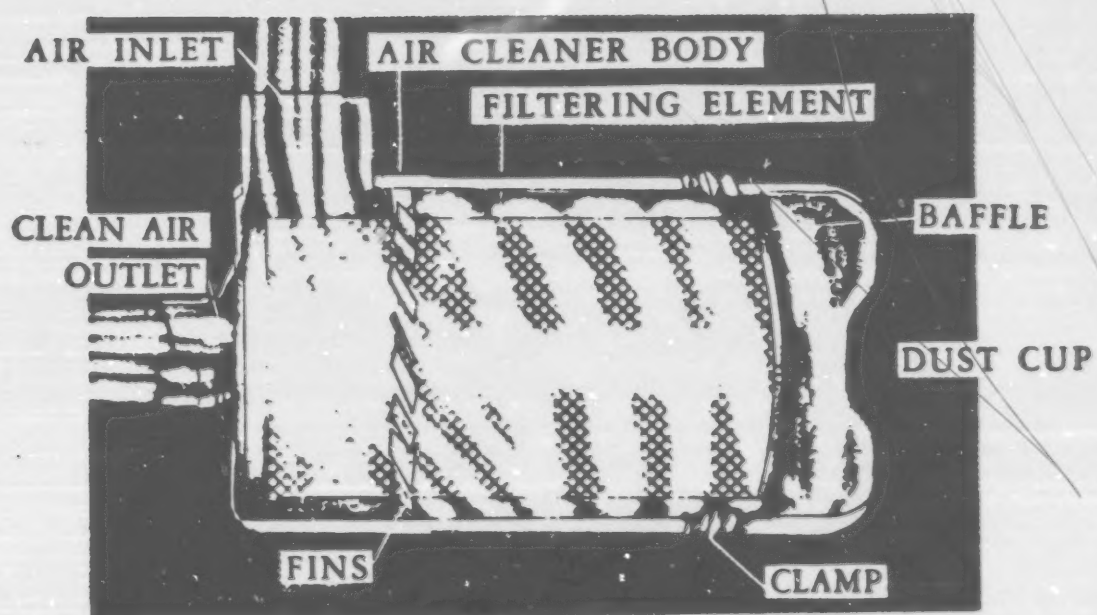
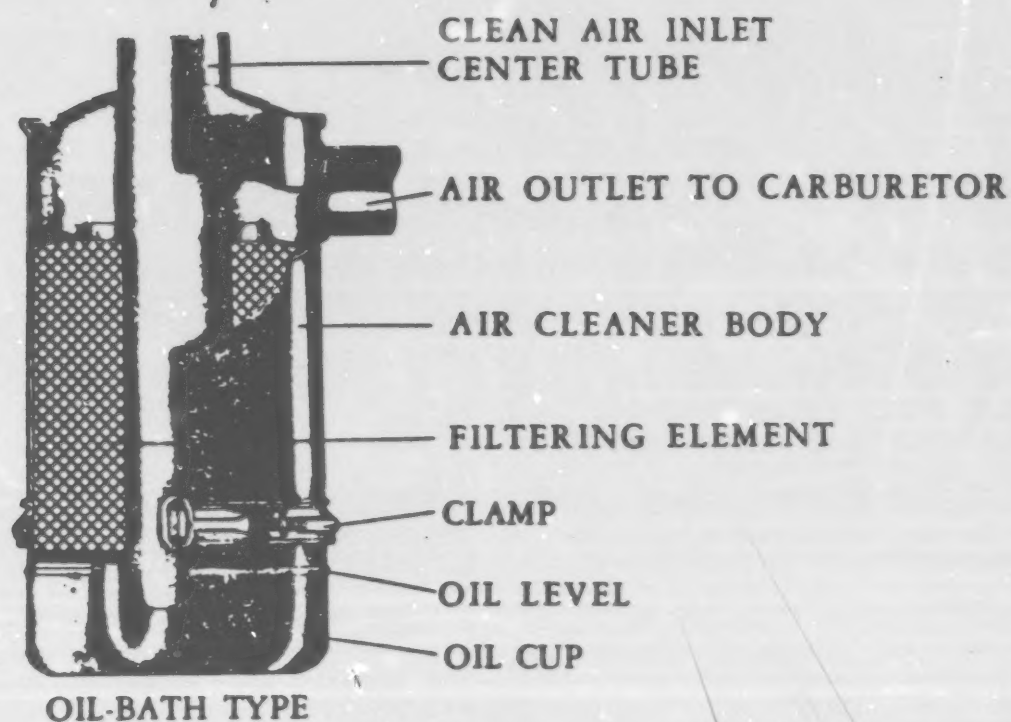
TRACTION BOOSTER GAUGE



MILES PER HOUR AND HOUR USE GAUGE

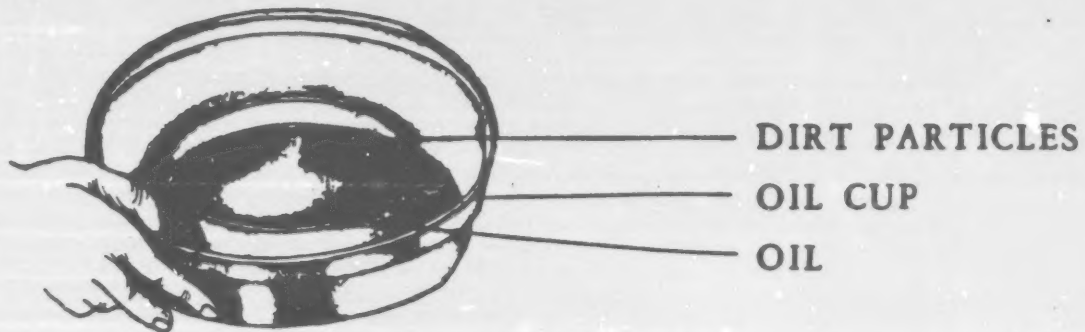
TRANSPARENCY V-2-A

TYPES OF AIR CLEANERS



DRY TYPE
TRANSPARENCY V-2-B

SERVICING OIL-BATH TYPE AIR CLEANER



HEAVY DUTY OIL BATH TYPE AIR CLEANER



CLEAN OIL CUP



REMOVE FOREIGN
MATERIAL FROM
SCREEN



REFILL OIL CUP
TO OIL LINE

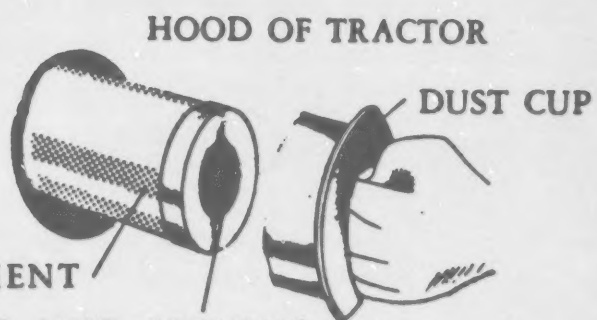
TRANSPARENCY V-2-C

DRY TYPE AIR CLEANER



RUBBER VALVE
TYPE DUST
UNLOADER

DUST PARTICLES

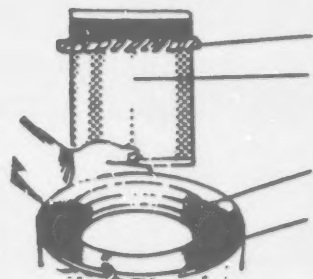


HOOD OF TRACTOR

DUST CUP

ELEMENT
HAND NUT OPENING

REMOVING DUST CUP



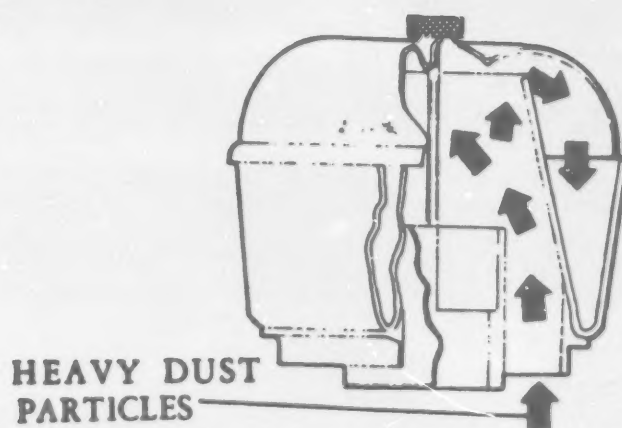
FINS

FILTERING ELEMENT

BAFFLE

DUST CUP

REMOVING FILTERING
ELEMENT

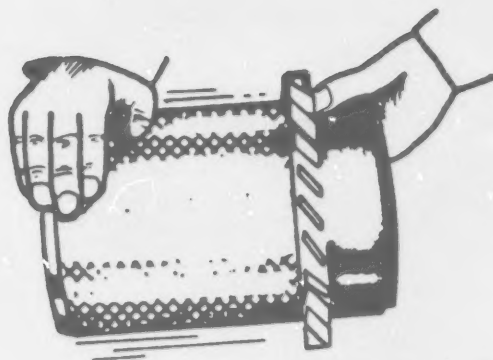


HEAVY DUST
PARTICLES

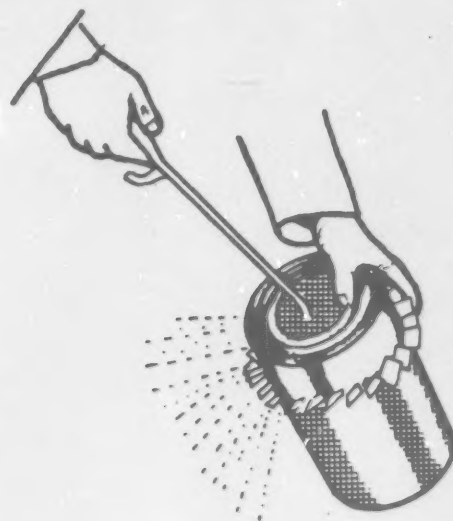
PRE-CLEANER

TRANSPARENCY V-2-D

CLEANING THE DRY ELEMENT



TAP ELEMENT TO LOOSEN DIRT



USE AIR TO
REMOVE DIRT



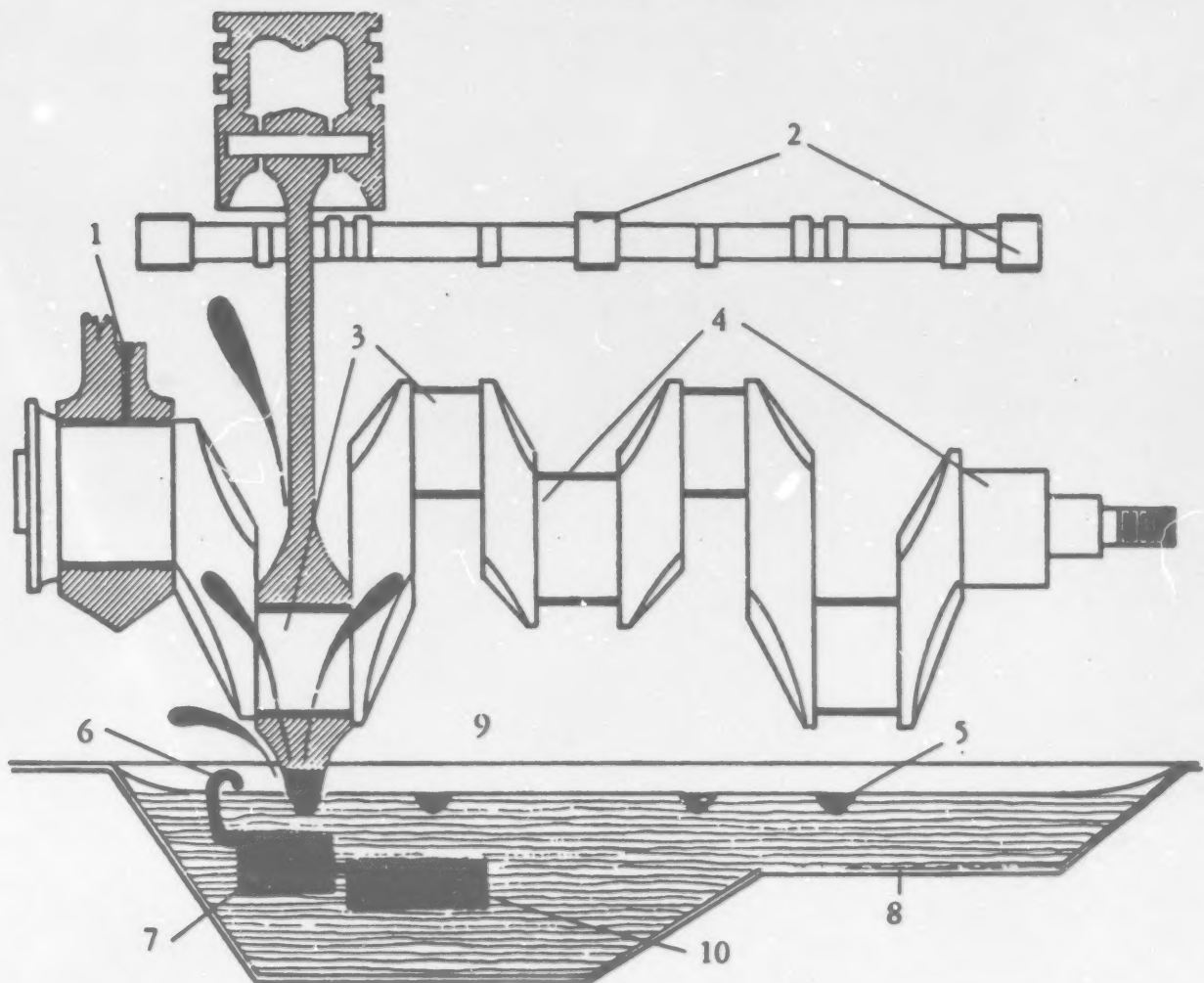
WASH ELEMENT
IN SOAPY WATER



RINSE ELEMENT
WITH CLEAN WATE

TRANSPARENCY V-2-E

LUBRICATING SYSTEM

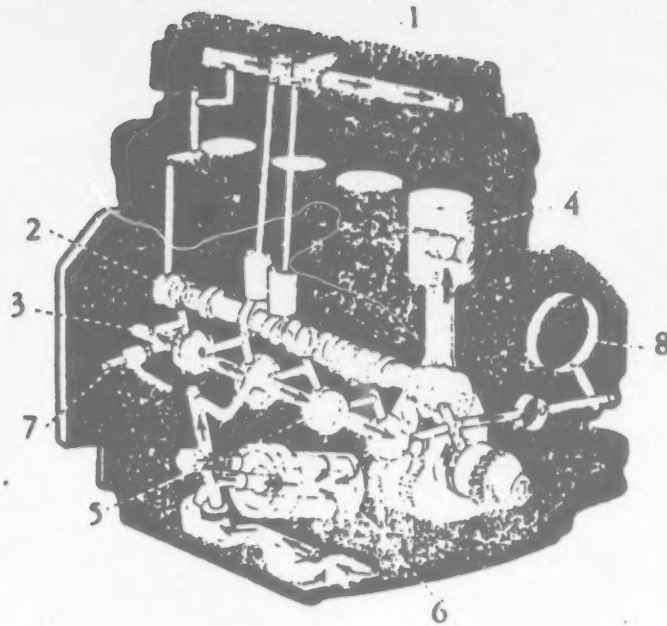


CIRCULATORY - SPLASH

- | | |
|----------------------|---------------------------|
| 1. OIL TROUGH | 6. SPLASH PAN SUPPLY TUBE |
| 2. CAMSHAFT BEARINGS | 7. OIL PUMP |
| 3. ROD BEARINGS | 8. OIL PAN |
| 4. MAIN BEARINGS | 9. OIL DIPPER |
| 5. SPLASH TROUGHS | 10. OIL STRAINER |

TRANSPARENCY V-2-F

LUBRICATING SYSTEM



FORCE FEED

1. TAPPET SHAFT
2. CAMSHAFT BEARINGS
3. MAIN OIL GALLERY
4. PISTON PIN BEARINGS
5. MAIN BEARINGS
6. OIL PUMP AND FILTER ASSEMBLIES
7. OIL PRESSURE SCREW
8. VENTILATOR PUMP

TRANSPARENCY V-2-G

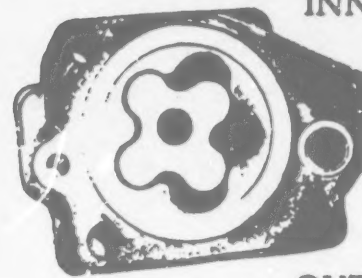
OIL PUMPS AND PRESSURE GAUGE



BODY

DRIVE GEAR

EXTERNAL PUMP

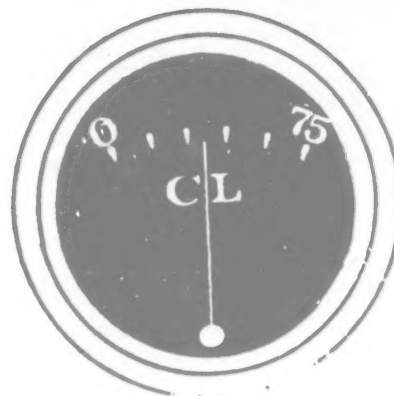


INNER ROTOR

BODY

OUTER ROTOR

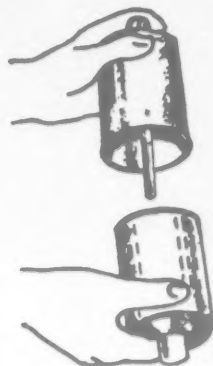
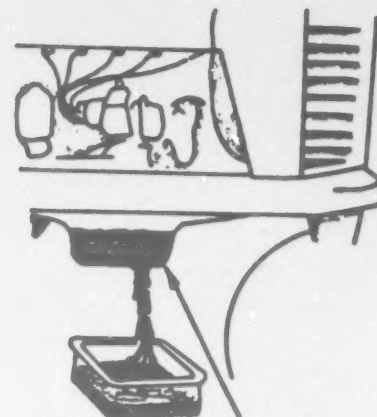
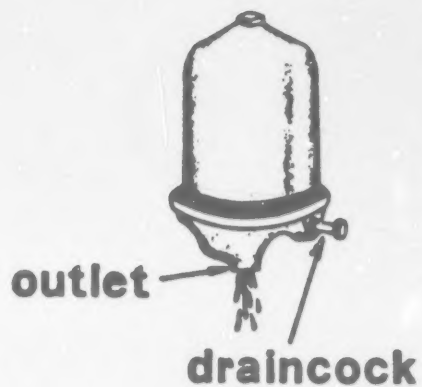
ROTOR PUMP



PRESSURE GAUGE

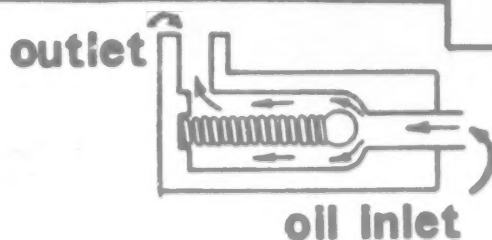
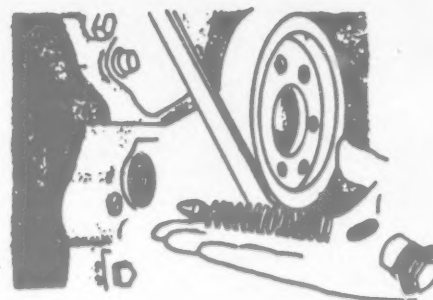
TRANSPARENCY V-2-H

DRAINING OIL FROM FILTER AND CRANKCASE



REPLACING FILTER ELEMENT

AN OIL PRESSURE VALVE



**LUBRICATING VALVE
OPENING**

LUBRICATION

TRANSPARENCY V-2-1

COOLING SYSTEMS



copper tube
filled with
low boiling
point liquid

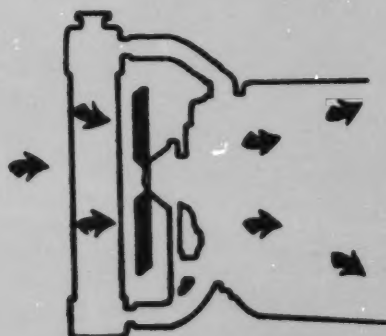
Bellows Type Thermostat



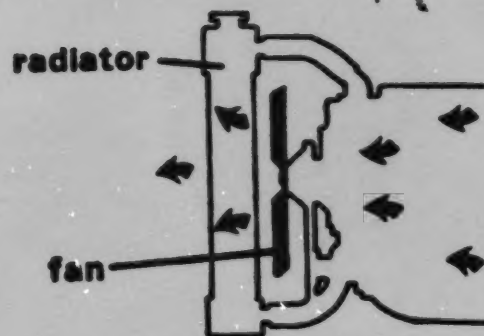
overflow pipe

radiator

Radiator Cap & Filler Neck

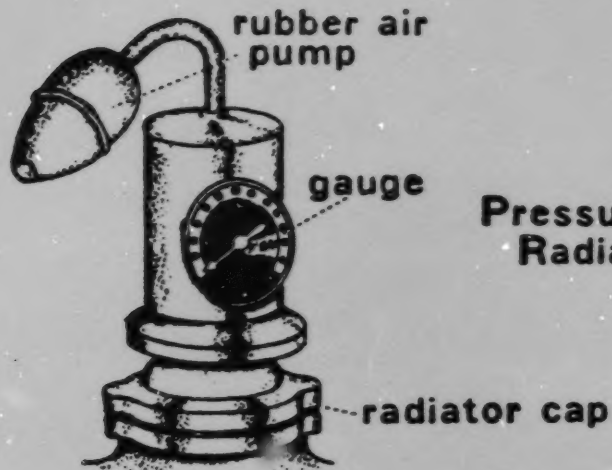


Suction Type Fan

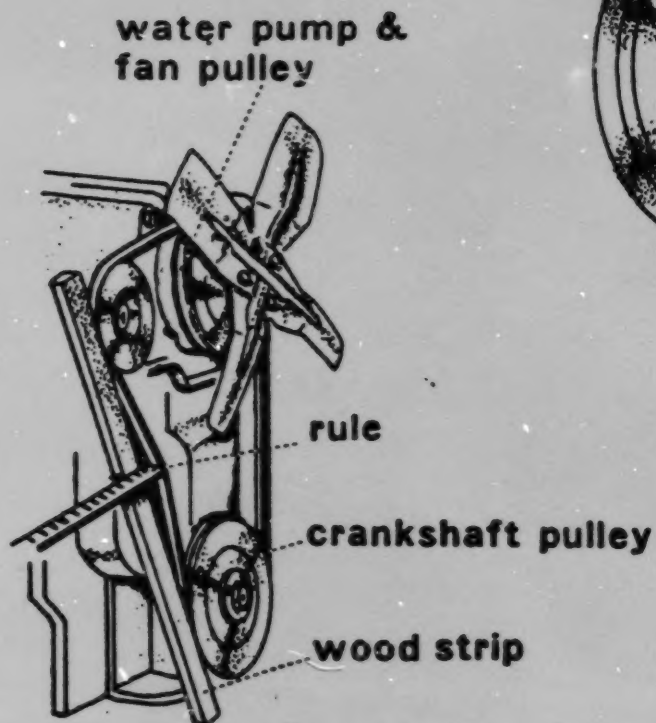


Blower Type Fan

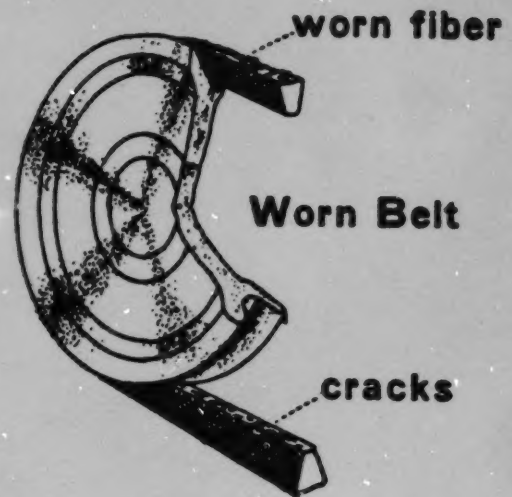
COOLING SYSTEM



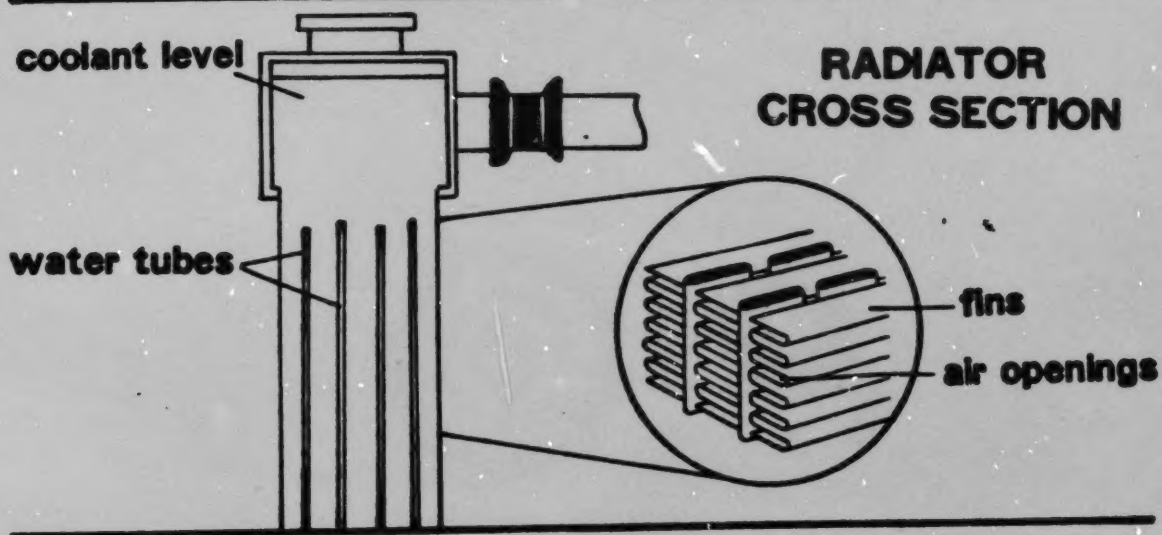
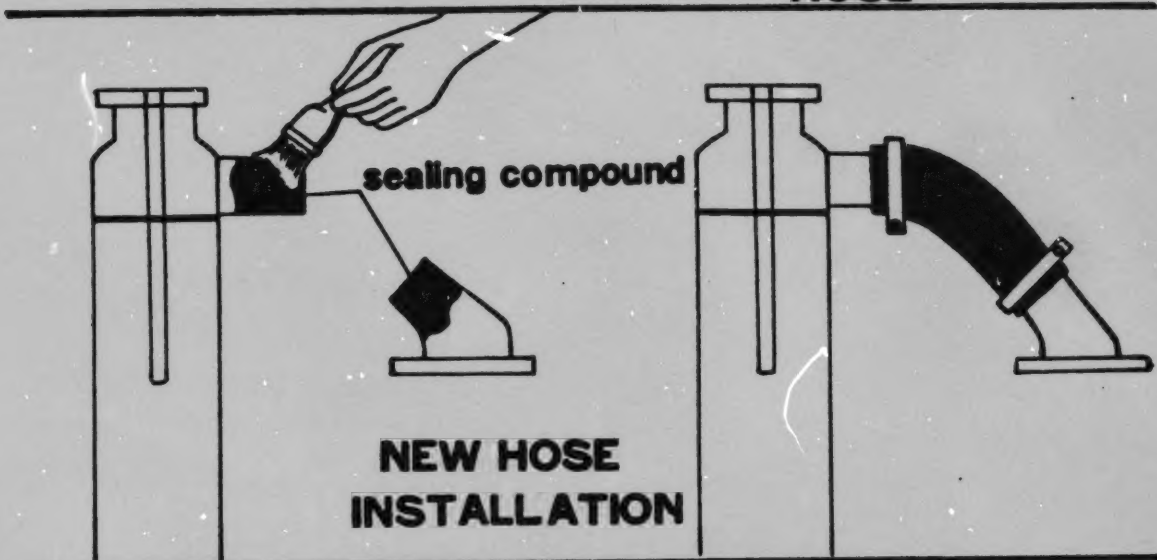
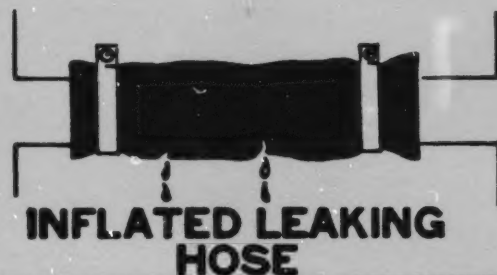
**Pressure Tester For
Radiator & Cap**



**Straight Edge Used
to Adjust Belt Tension**

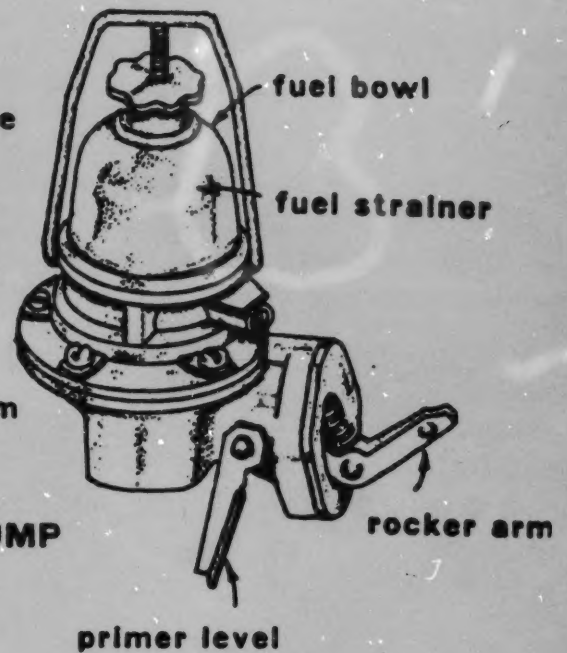
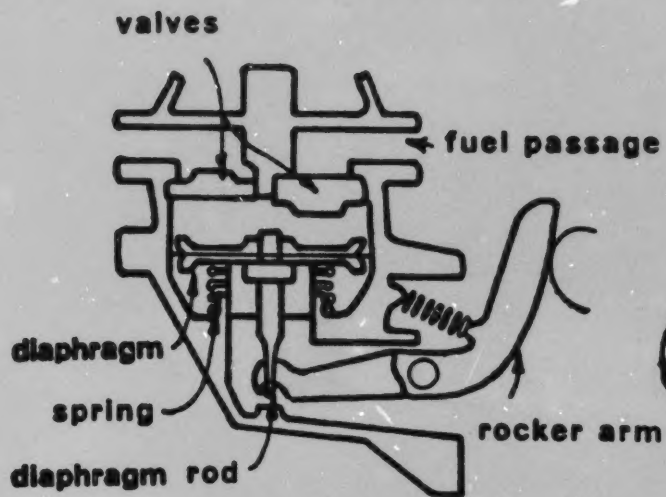


Cooling System

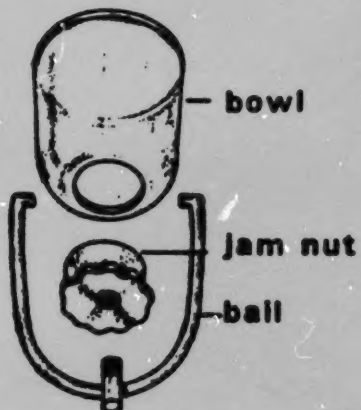
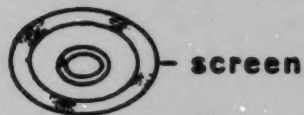
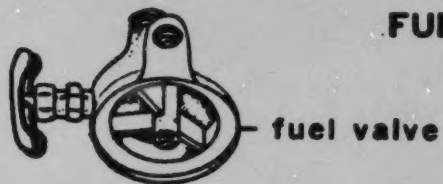


TRANSPARENCY V-2-L

FUEL SYSTEM



FUEL PUMP

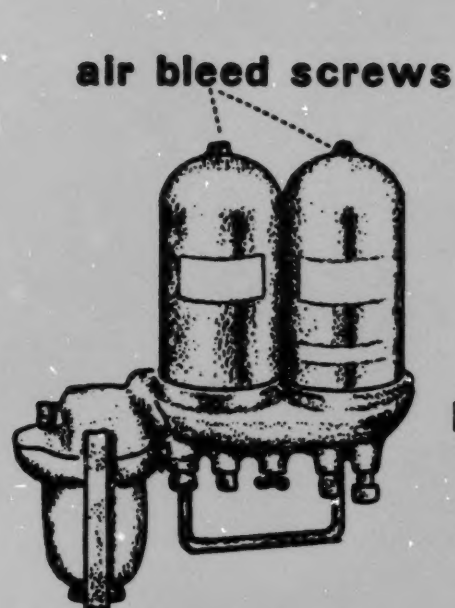


FUEL FILTER

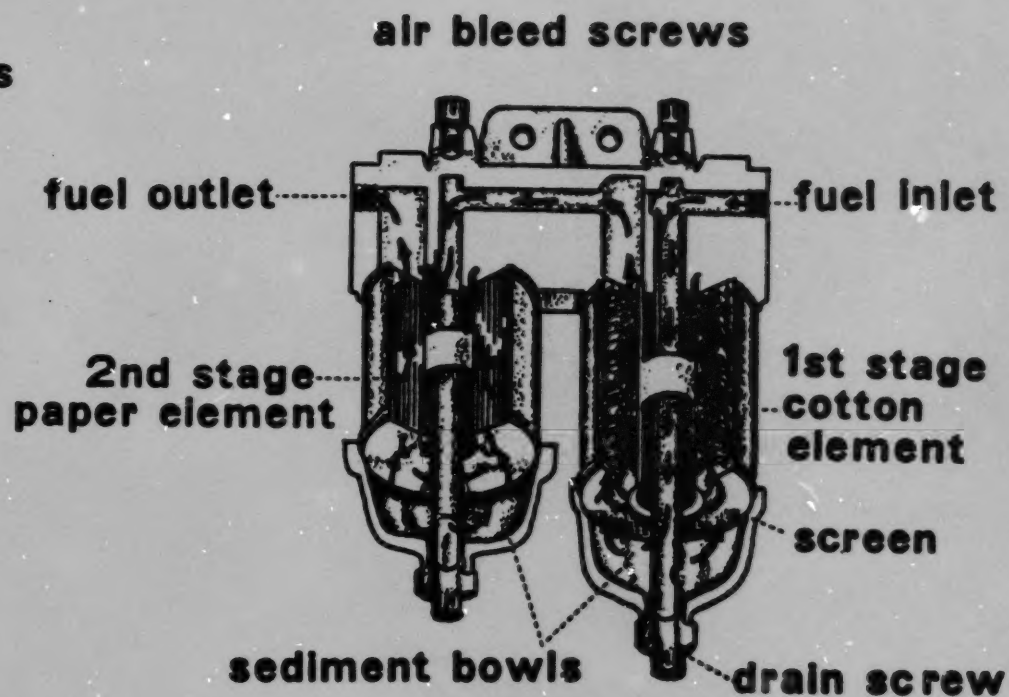


TRANSPARENCY V-2-M

FUEL SYSTEM



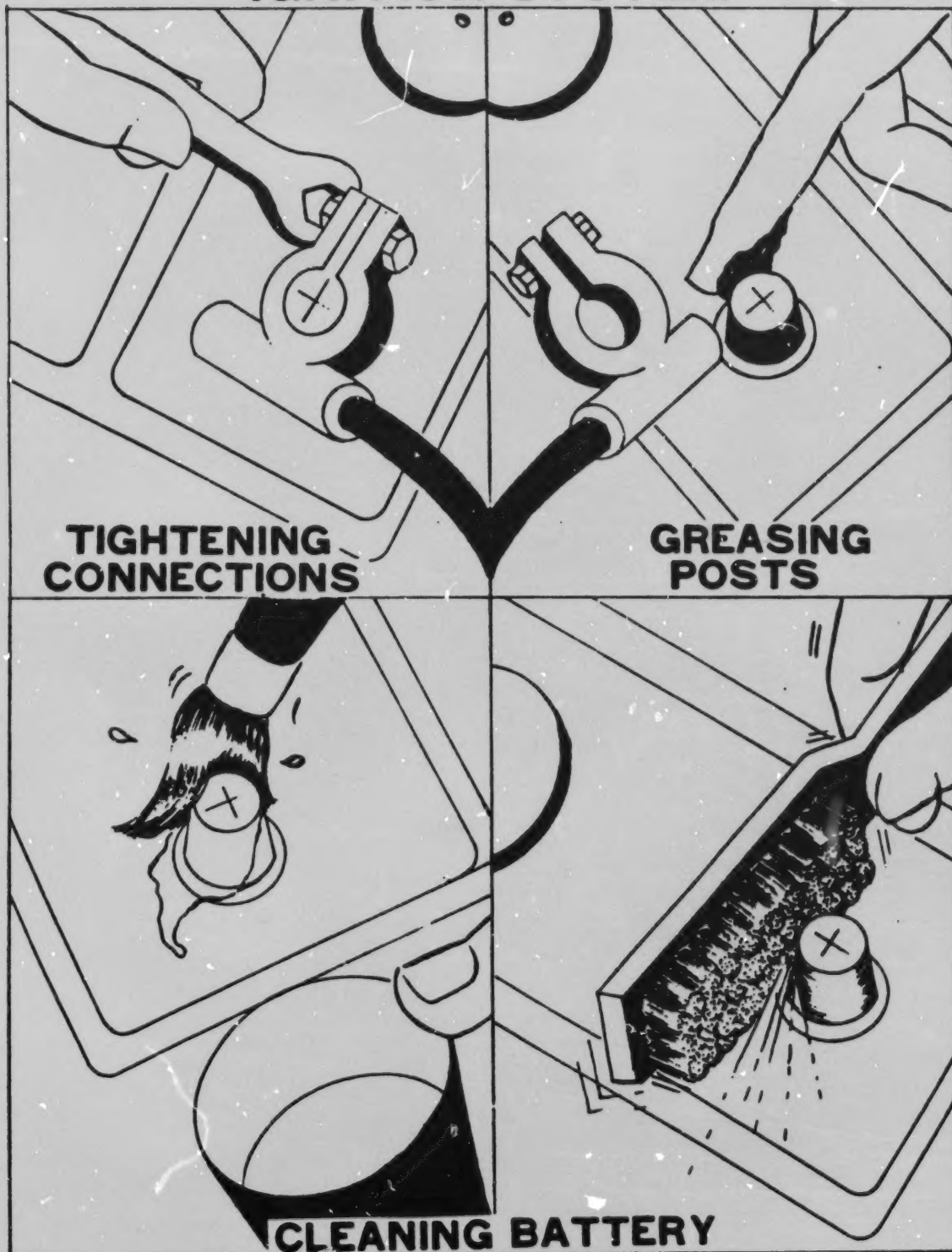
**Diesel Fuel Filters
With Separate
Sediment Bowl**



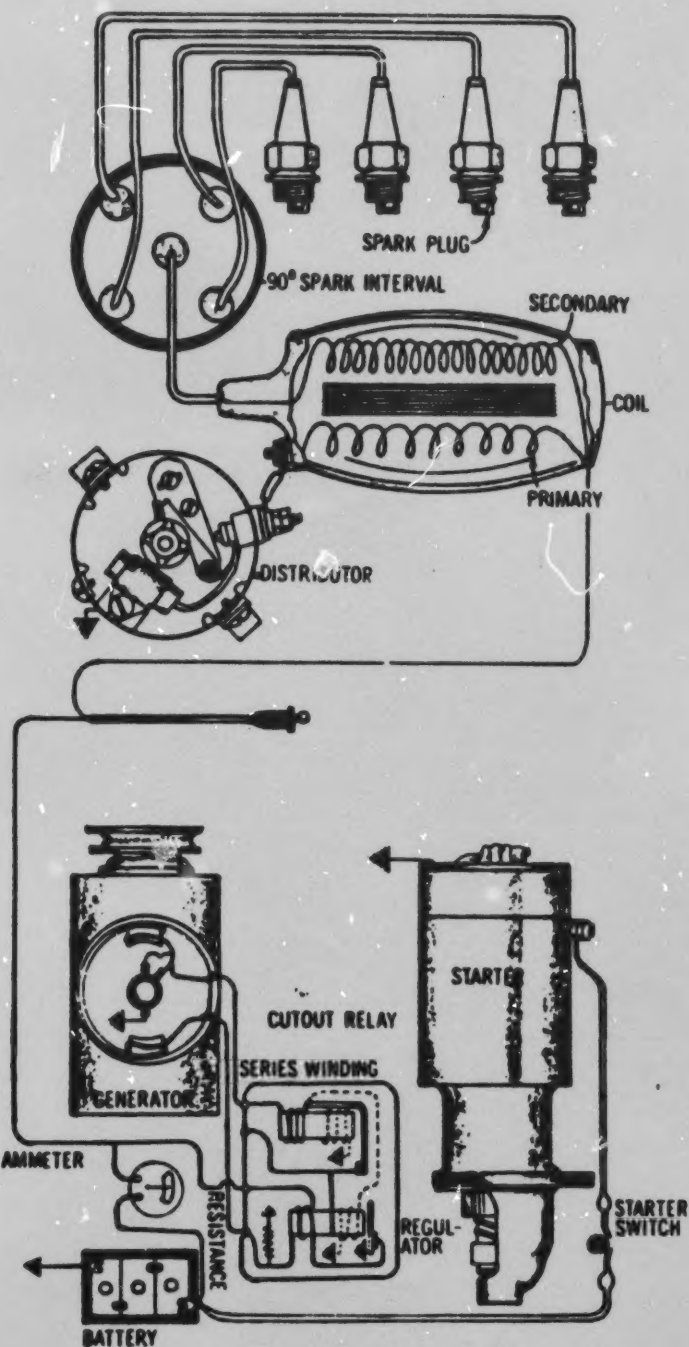
**Diesel Fuel
Filters Complete**

TRANSPARENCY V-2-N

IGNITION SYSTEM



IGNITION SYSTEM



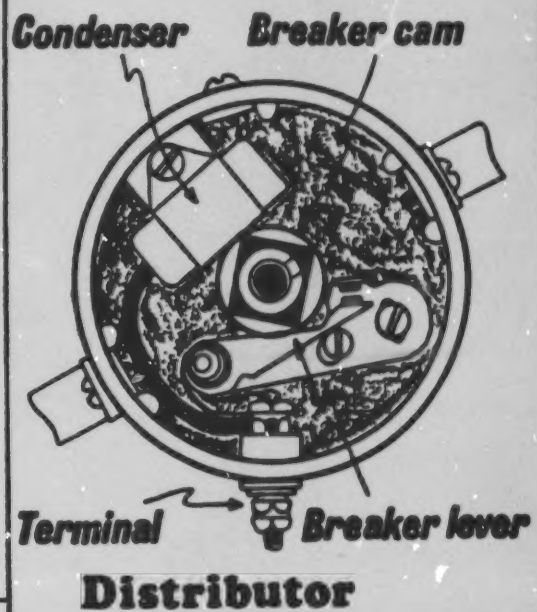
BATTERY SYSTEM

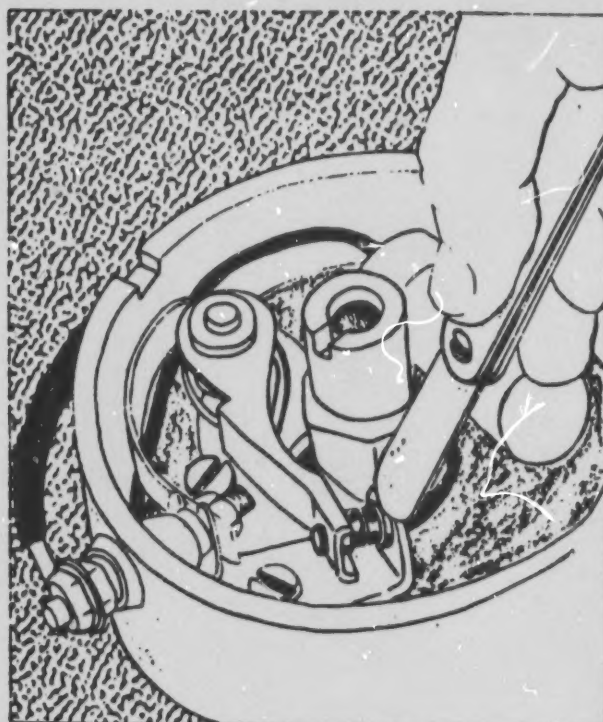
Ignition System



Distributor Cap

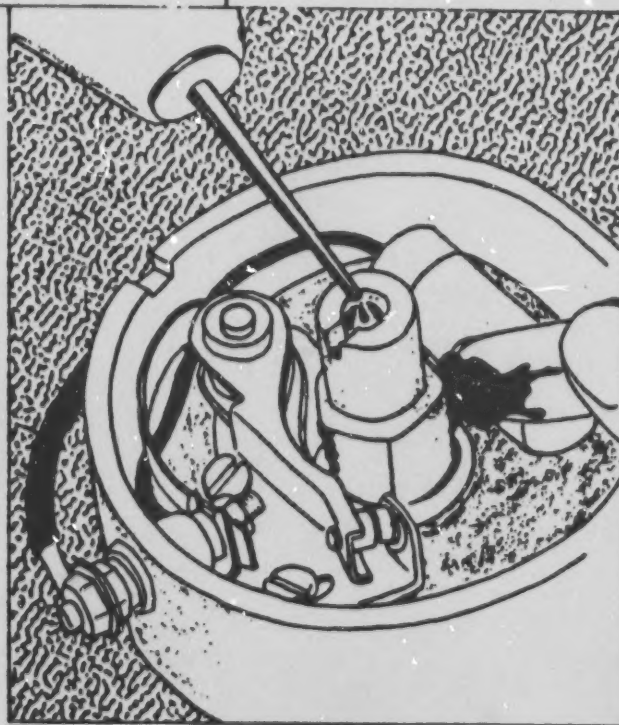
Rotor





Setting Points

Lubricating Distributor and Cam



TRANSPARENCY V-2-R

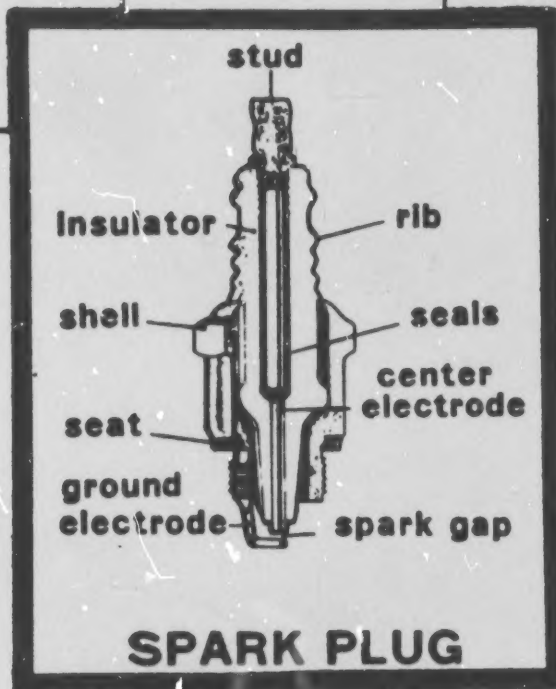
IGNITION SYSTEM



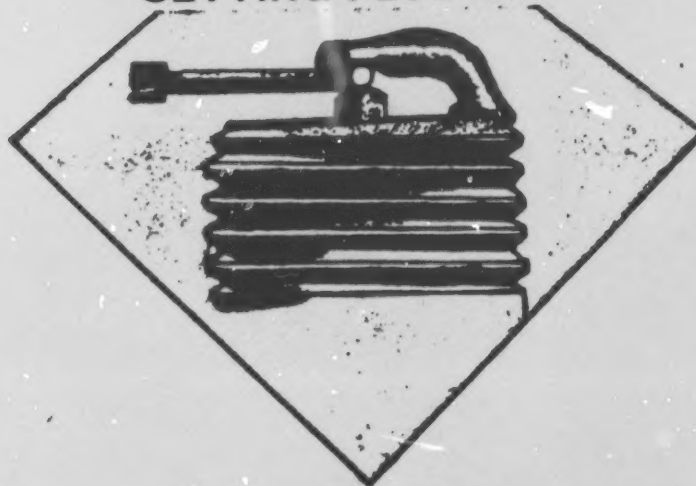
**CLEANING
INSIDE
OF PLUG**



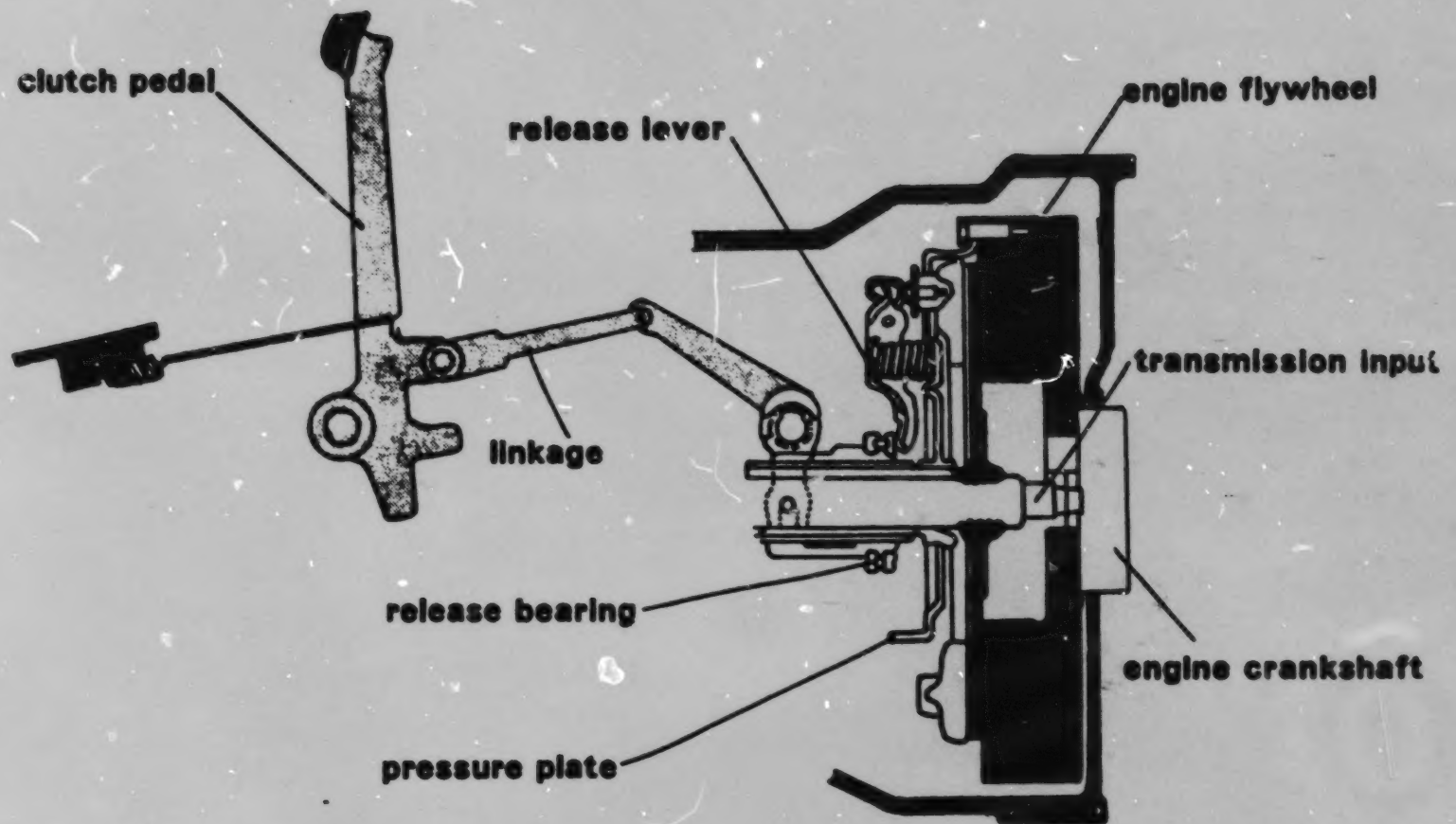
**CLEANING
OUTSIDE
OF PLUG**



SETTING PLUG GAP



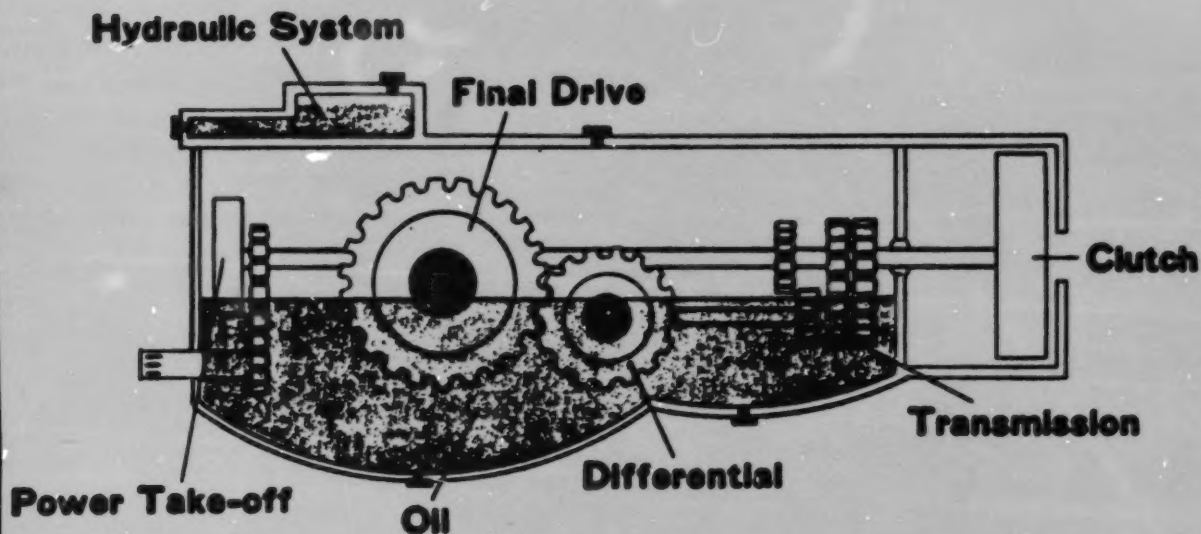
POWER TRAIN



CLUTCH AND CLUTCH LINKAGE

TRANSPARENCY V-2-T

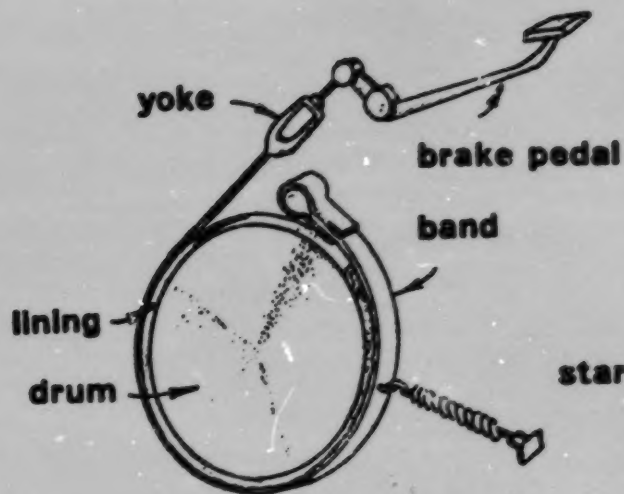
Lubrication



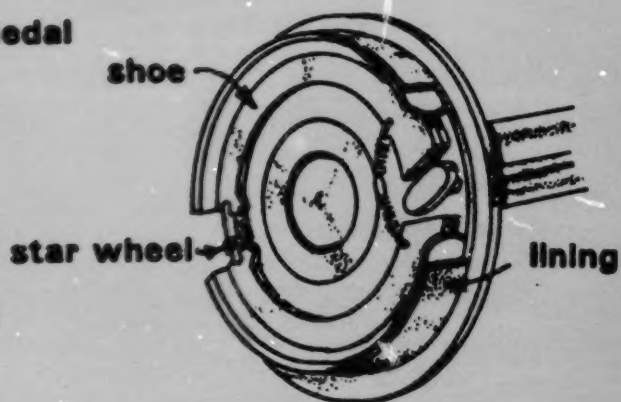
DRIVE MECHANISM

TRANSPARENCY V-2-U

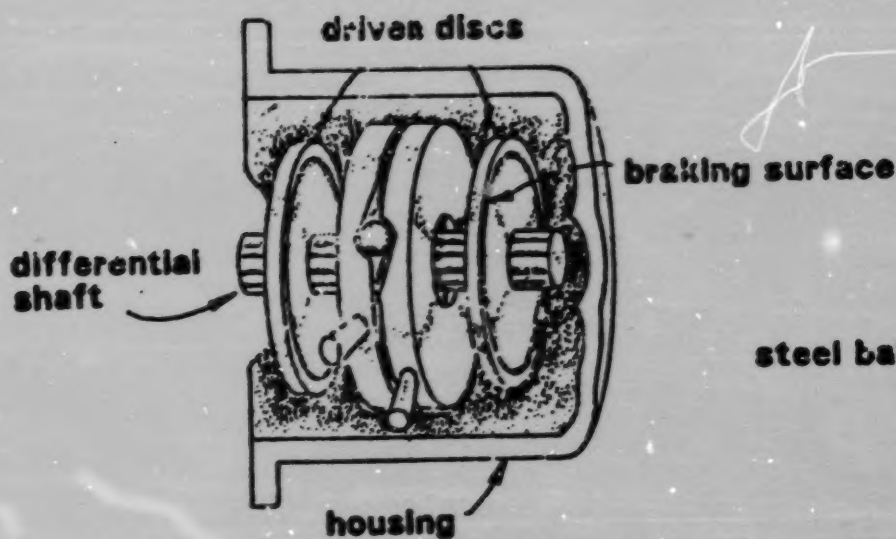
TRACTOR BRAKES



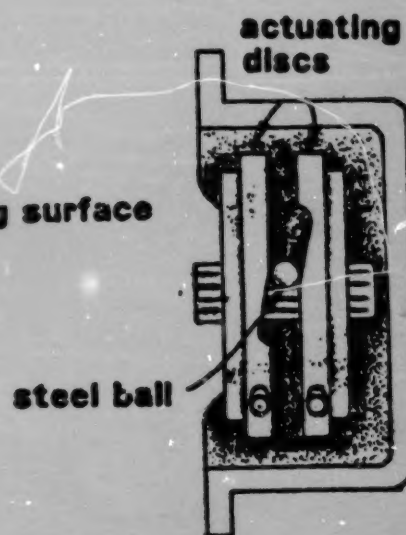
BAND BRAKE



SHOE BRAKE

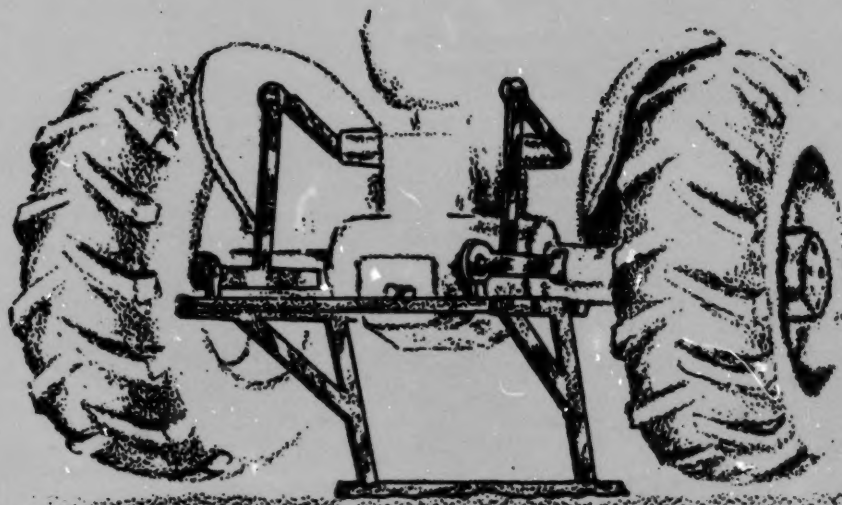


DISC BRAKE

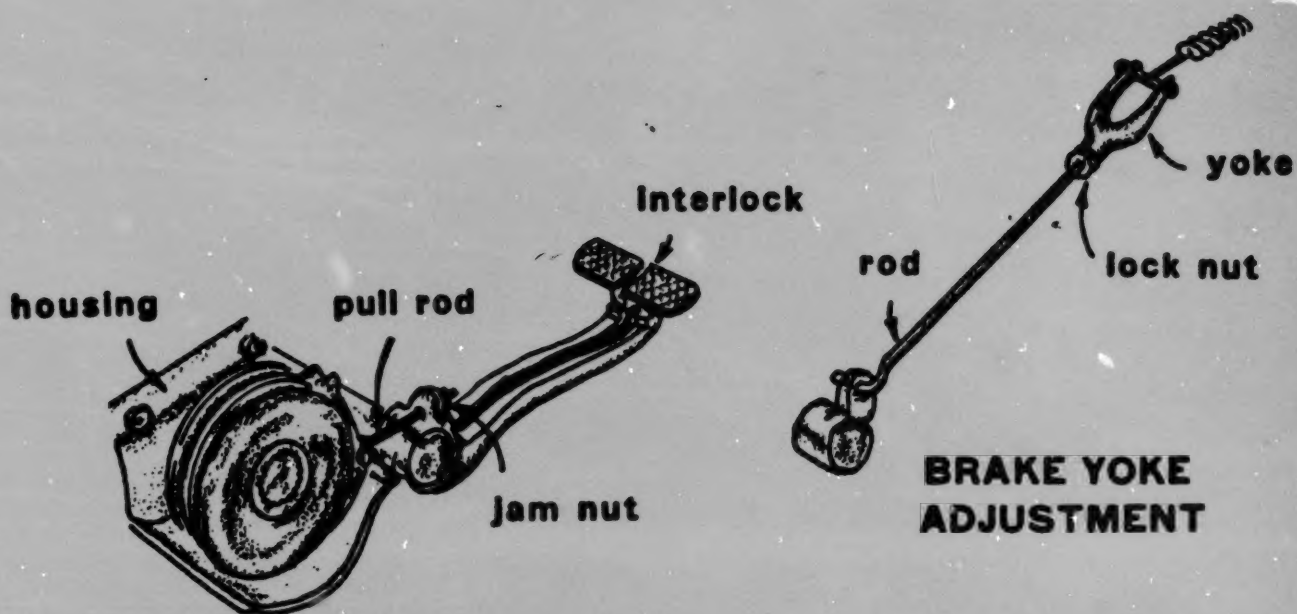


TRANSPARENCY V-2-V

TRACTOR BRAKES



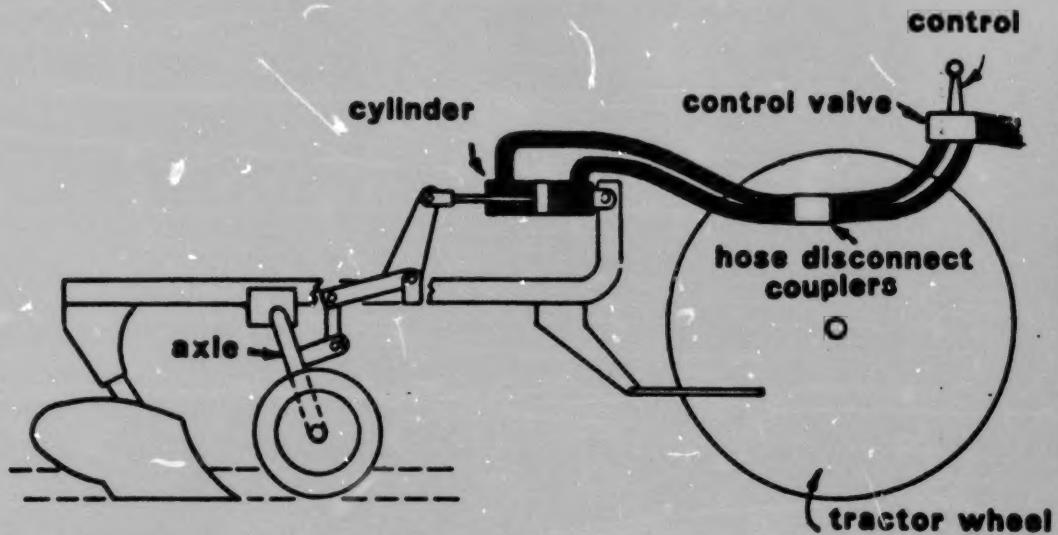
REAR WHEELS OFF GROUND



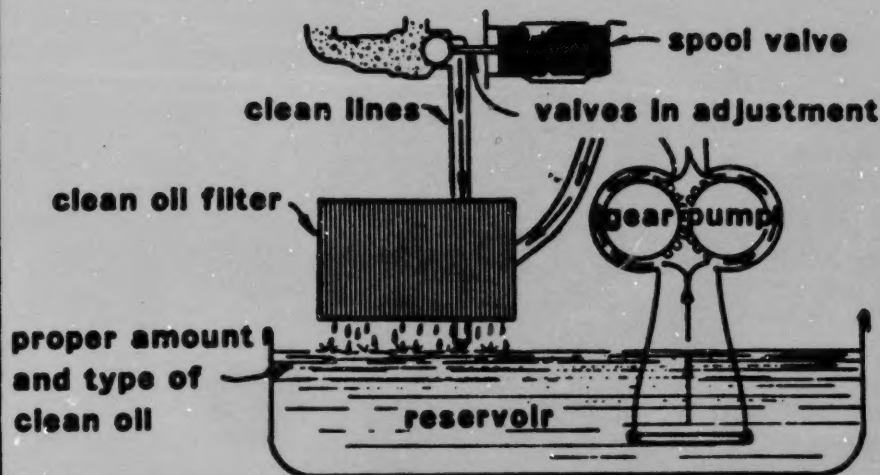
DISC BRAKES & PEDALS

TRANSPARENCY V-2-W

HYDRAULICS

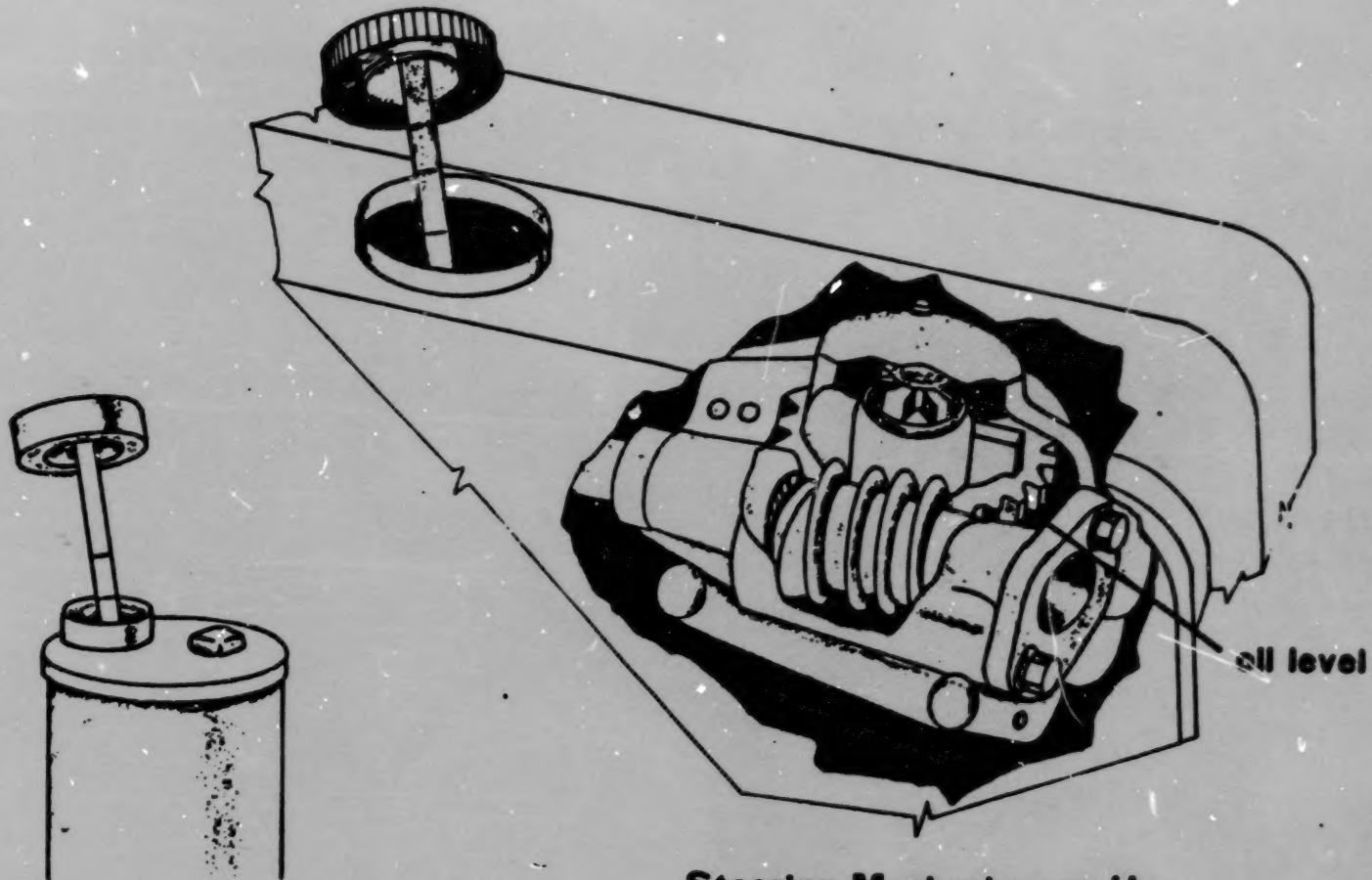


METHOD OF RAISING A PLOW BY REMOTE CONTROL



ELIMINATION OF MAINTENANCE PROBLEMS

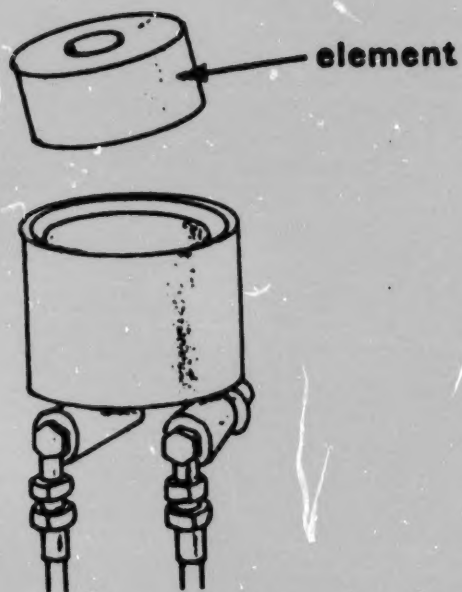
STEERING SYSTEMS



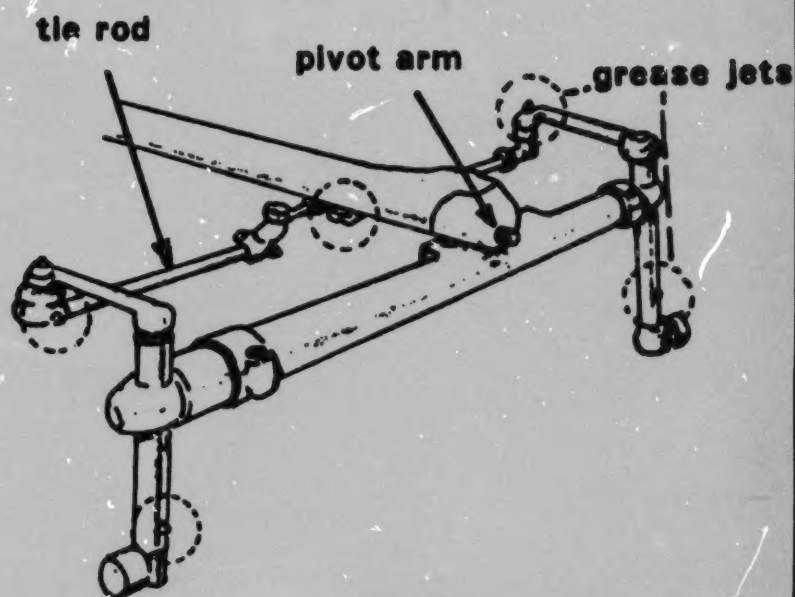
**Use of Dipstick to Check Oil
Level Hydraulic System**

**Steering Mechanism on Upper
Pedestal Manual System**

STEERING SYSTEM



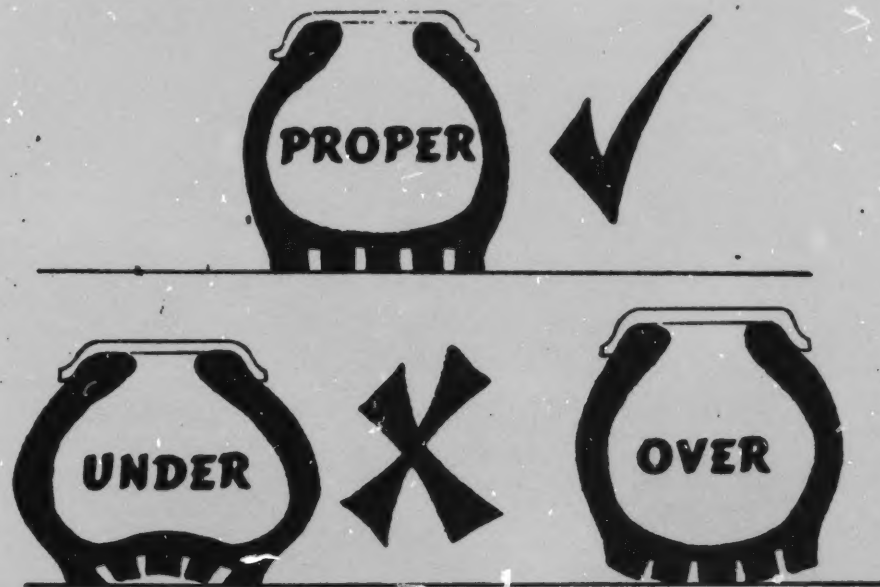
Hydraulic-Steering Filter
Element in Reservoir



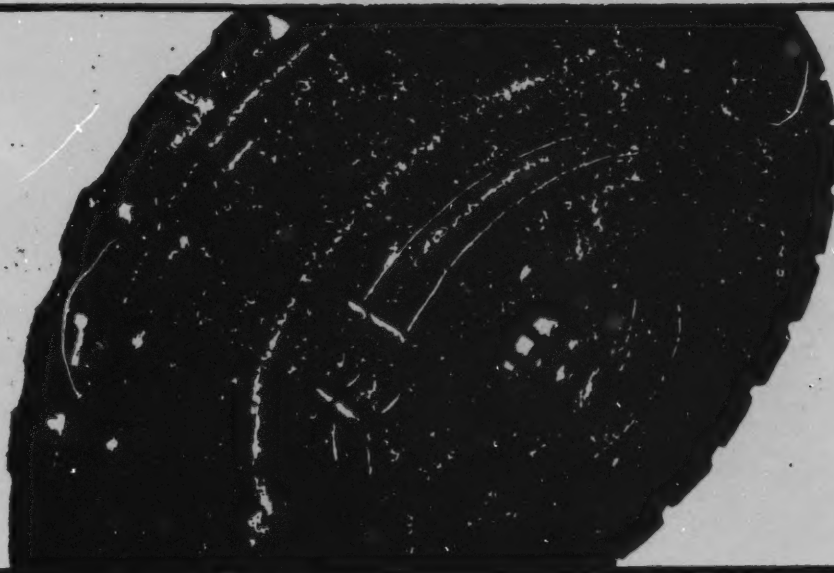
Tractor Front-End Assembly

TRANSPARENCY V-2-Z

TRACTOR TIRES



INFLATION



WHEEL WEIGHTS

TRANSPARENCY V-2-AA

TRACTOR TIRES

FRONT TIRES

SIZE	PRESSURE	
	min.	max.
<u>4-ply</u>		
All 4.00 sizes*	20 lbs.	44 lbs.
All 5.00 sizes	20 lbs.	36 lbs.
All 5.50 & 6.00 sizes	20 lbs.	32 lbs.
All 6.50 sizes	20 lbs.	28 lbs.
All 7.50 sizes	20 lbs.	24 lbs.
<u>6-ply</u>		
All 5.50 & 6.00 sizes	20 lbs.	48 lbs.
All 6.50 sizes	20 lbs.	44 lbs.
All 7.50 sizes	20 lbs.	36 lbs.

TRANSPARENCY V-2-BB

TRACTOR TIRES

REAR TIRES			
TIRE SIZE		PRESSURE	
old	new	min.	max.
<u>4-ply</u>			
9 sizes	All 9.5	12 lbs.	18 lbs.
10 sizes	All 11.2	12 lbs.	16 lbs.
11 sizes	All 12.4	12 lbs.	14 lbs.
12 sizes	All 13.6	14 lbs.	14 lbs.
	13.9	14 lbs.	14 lbs.
<u>6-ply</u>			
10 sizes	All 11.2	12 lbs.	26 lbs.
11 sizes	All 12.4	12 lbs.	22 lbs.
12 sizes	All 13.6	14 lbs.	20 lbs.
	13.9	14 lbs.	20 lbs.
13 sizes	All 14.9	14 lbs.	18 lbs.
	15.5	14 lbs.	18 lbs.
14 sizes	All 16.9	16 lbs.	16 lbs.
15 sizes	All 18.4	16 lbs.	16 lbs.

TRANSPARENCY V-2-CC

INSTRUCTIONAL AREA: Agriculture Mechanics

INSTRUCTIONAL UNIT V: Tractor Maintenance, Operation, and Safety

LESSON 3: Tractor Operation

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Operate tractor in the proper manner.
2. Specific:
 - a. Start the tractor.
 - b. Use clutch to engage transmission.
 - c. Properly shift gears.
 - d. Drive the tractor.

B. Review of Teaching Materials

1. Fundamentals of Machine Operation: Tractors. Moline, Ill.: Deere and Company, 1974.
2. Tractor Operation and Daily Care. Athens, Ga.: American Association for Vocational Instructional Materials, 1967.

C. Special Arrangements

If the school does not have a tractor, have a student bring one from home or borrow one from a local equipment dealer to have students drive.

II. Presentation of Lesson

A. Motivation

Visit dealerships to see different types and sizes of tractors.

B. Content Outline

1. Starting the tractor engine -- Tractor manufacturers have installed different types of safety devices to prevent accidental starting of the tractor. Many injuries occur each year because a tractor is started accidentally or because careless operators failed to take necessary precautions. Before starting, the operator should always remember to:
 - a. Read and study the operator's manual.
 - b. Make sure everyone is well away from the tractor.
 - c. Make sure that the PTO and all other controls are in the off or neutral position and that the gear shift is in the neutral or park position.
 - d. Fully depress the clutch pedal before starting the engine.
 - e. Before moving the tractor, make sure that every one is clear of the tractor.
2. Starting gasoline tractor engines includes the following steps.
 - a. Turn the key or ignition switch to the "on" position making sure that all warning lights are working.
 - b. Move the throttle to the one-third or one-half speed position.
 - c. Pull out the choke control.
 - d. Engage the starter.
 - e. Release the starter after the engine starts and slowly push in the choke control to keep the engine running smoothly while it warms up. When the engine reaches operating temperature, push the choke control all the way in.
3. Starting diesel tractor engines includes the following steps.
 - a. Turn the key to the "on" position,
 - b. Check warning lights and instruments for proper operation,
 - c. Open the fuel shut-off control and engage the starter, and

- d. Release the starter switch after the engine starts.
- 4. General starting procedures for all types of engines include the following points.
 - a. Always check the fuel gauge before starting the engine.
 - b. Never operate the starter motor for more than 30 seconds continuously.
 - c. Allow the engine to reach operating temperature before applying any load to the drawbar.
 - d. Do not start a tractor engine in an enclosed building.
 - e. Watch all lights and gauges.
 - f. After the tractor engine has started and even though the gearshift is in neutral or park, engage the clutch slowly.
- 5. Stopping tractor engines -- Before stopping a tractor engine, allow it to idle for a few minutes to help cool down the engine. The following procedures for stopping an engine are as follows:
 - a. Place the gear shift lever in park (or in neutral and lock the brakes),
 - b. Disengage all other drives,
 - c. Lower implements,
 - d. Turn off all electrical switches and the ignition switch,
 - e. On diesel engines, turn off the fuel flow with the fuel shut-off valve, and
 - f. Remove the key to prevent accidental starting.
- 6. Driving the tractor requires two essential skills.
 - a. Operating the clutch -- If the tractor is equipped with a manual shift or synchronized transmission, never engage the clutch quickly. This could put a tremendous strain on the power train and could cause the tractor to tip over backwards.

Never ride the clutch pedal; that is, do not rest your foot on the pedal while the tractor is in motion.

When increasing speed, do so slowly. Opening the throttle suddenly can cause the tractor to tip over backwards and causes strain on the power train. Never engage the clutch while the engine is operating at high speeds. Doing so can burn or score the clutch facing and damage other tractor parts.

- b. Operating the transmission -- Today's tractors are available with several types of transmissions that include the following:
 - 1) Manual shift -- Use these procedures.
 - a) Depress clutch pedal, shift the range lever into the desired speed range and desired gear within the range.
 - b) Operate the engine at a medium to fast idle and slowly release the clutch pedal.
 - c) After the clutch is fully released, slowly move the throttle to the desired operating speed.
 - 2) Synchronized transmission -- Use these procedures.
 - a) Depress clutch pedal, shift the range lever into the desired speed range and desired gear within that range.
 - b) Operate the engine at a medium to fast idle and slowly release the clutch pedal.
 - c) After clutch is fully released, slowly move the throttle to the desired operating speed.
 - 3) Hydraulically engaged transmission -- Use these procedures.
 - a) It is not necessary to depress the clutch pedal while starting the engine or to shift gears while the tractor is in motion.
 - b) To start the tractor moving, simply place the gearshift lever into low gear while the engine is running slowly. Then move the lever, gear by gear to the desired operating position and increase the throttle speed.
 - c) The inching pedal replaces a clutch pedal on tractors of this type. This pedal is provided for emergency stops and to help in

hitching the tractor to machinery. Its operation is identical to the clutch pedal except it does not need to be used to start the tractor in motion or to shift gears.

C. Suggested Student Activities

Have each student demonstrate the proper way to drive a tractor from starting the engine through shutting it "off." If possible, secure tractors with different types of transmissions for this purpose.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VI: Small Engines

LESSON 1: Advanced Troubleshooting and Servicing

I. Preparation for Instruction

A. Objectives

1. **Terminal:** Troubleshoot and service a small engine properly and safely.
2. **Specific:**
 - a. List general reasons why small engines give trouble.
 - b. Explain the need for regular servicing of small engines.
 - c. Accurately diagnose and correct engine malfunctions.

B. Review Teaching Material

1. Service and Repair Instructions. Milwaukee, Wisconsin: Briggs and Stratton Corporation, 1982.
2. Small Engines, Volume I and II. 4th edition. Athens, Georgia: American Association for Vocational Instructional Materials. 1979.

C. Special Arrangements

1. **Materials Needed**
 - a. Several small engines
 - b. Several sets of recommended tools
2. Shop or laboratory with suitable tables or benches

II. Presentation of Lesson

A. Motivation

1. Demonstrate to students a small engine running poorly.
(Example: The carburetor may be set too rich.)
2. With the engine running, correct the problem.
3. Point out to students that many engine troubles are due to a lack of understanding of how the engine operates.

B. Content Outline

1. Terms

- a. Troubleshooting -- locating and correcting troubles in small engines
- b. Servicing -- to repair or provide maintenance
- c. Systematic -- following a plan or guide
- d. Operator's manual -- a book provided by the manufacturer and obtained at the time of purchase of the small engine for use in operating and servicing the engine
- e. Diagnosis -- to investigate or analyze the cause of trouble in a small engine

2. Reasons why small engines give trouble:

- a. Lack of proper service,
- b. Lack of proper operation,
- c. Lack of proper maintenance, and
- d. Lack of proper repair.

3. Regular servicing of small engines

If one expects to get trouble-free service from a small engine, it is generally accepted that one must take time to service it regularly. When this should be done varies with the different manufacturers' recommendations, the operating conditions, and the type of servicing to be performed.

General agreement exists with most manufacturers as to minimum times of these services, such as:

- a. Before each operation...
 - 1) Check the crankcase oil level in 4 cycle engines.
 - 2) Fill the fuel tank with clean, fresh regular gasoline. A 2 cycle engine should have the correct amount of the proper oil thoroughly mixed with the gasoline.
- b. Every 25 hours or more often if the engine operates in extremely dirty or dusty conditions --

- 1) Service carburetor air cleaner, and
 - 2) Change the crankcase oil in 4 cycle engines.
- c. Perform an annual cleaning and general inspection of the engine.

One way to save time and trouble in servicing and operating an engine is to save and use the operator's manual that comes with the engine. It contains important information that one must have when doing many of the servicing jobs.

4. Troubleshooting Engine Malfunctions

Most complaints concerning engine operation can be classified as one or a combination of the following:

- a. Will not start,
- b. Hard starting,
- c. Kicks back when starting,
- d. Lacks power,
- e. Vibration,
- f. Erratic operating,
- g. Overheating, and
- h. High oil consumption.

When the cause of malfunction is not readily apparent, perform a check of the compression, ignition, and carburetion systems. This check-up, performed in a systematic manner, can usually be done in a matter of a few minutes. It is the quickest and surest method of determining the cause of failure. It may also point up possible causes of future failures that can be corrected at this time.

REVIEW: Check-up, A Guide to Troubleshooting

C. Suggested Student Activity

1. Troubleshoot a small engine.
2. Service a small engine.

CHECK-UP, A GUIDE TO TROUBLESHOOTING*

Check Compression -- Spin flywheel in reverse rotation (counterclockwise) to obtain accurate compression check. The flywheel should rebound sharply, indicating satisfactory compression. If compression is poor, look for:

- | | |
|-------------------------------|-----------------------------------|
| --- loose spark plug | --- insufficient tappet clearance |
| --- loose cylinder head bolts | --- warped cylinder head |
| --- blown head gasket | --- worn bore and/or rings |
| --- burnt valves and/or seats | --- broken connecting rod |

Check Ignition -- Remove the spark plug. Spin the flywheel rapidly with one end of the ignition cable clipped to the 19051 tester and with the other end of the tester grounded on the cylinder head. If the spark jumps the .166" tester gap, you may assume the ignition system is functioning satisfactorily. Try a new spark plug.

NOTE: Flywheel must rotate at least 350 RPM with Magnetron Ignition. If spark does not occur, look for:

- | | |
|--|---|
| --- incorrect armature air gap | --- shorted ground wire when so equipped |
| --- worn bearings and/or shaft flywheel side | --- shorted stop switch when so equipped |
| --- sheared flywheel key | --- condenser failure |
| --- incorrect breaker point gap | --- armature failure |
| --- dirty or burned points | --- improperly operating interlock system |
| --- breaker plunger stuck or worn | --- defective magnetron module |

NOTE: If engine runs but misses during operation, a quick check to determine if ignition is or is not at fault can be made by inserting the 19051 tester between ignition cable and the spark plug. A spark miss will be readily apparent. While conducting this test on a Magna-matic equipped engine, Models 9, 14, 19, and 23, set the tester gap at .060".

Check Carburetion -- Before making a carburetion check, be sure the fuel tank has an ample supply of fresh, clean gasoline (one half tank on vacu-jet engines). On gravity feed (flo-jet) models, see that the shut-off valve is open and fuel flows freely through the fuel lines. On all models, inspect and adjust the needle valves. Check to see that the choke closes completely. If engine will not start, remove and inspect the spark plug. If it is wet, look for:

- | | |
|-----------------------------------|--------------------------------------|
| --- overchoking | --- water in fuel |
| --- excessively rich fuel mixture | --- inlet valve stuck open (flo-jet) |

If plug is dry, look for:

- | | |
|---|--|
| --- leaking carburetor mounting gaskets | --- gummy or dirty screen or check valve (pulsajet and vacu-jet carburetors) |
| --- inlet valve stuck shut (flo-jet carburetor) | --- inoperative pump (pulsajet) |

A simple check to determine if the fuel is getting to the combustion chamber through the carburetor is to remove the spark plug and pour a small quantity of gasoline through the spark plug hole. If the engine fires a few times and then quits, look for the same condition as for a dry plug.

*Adapted from Briggs and Stratton, page 6-7

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VI: Small Engines

LESSON 2: Repair and Overhaul Procedures

I. Preparation for Instruction

A. Objectives

1. Terminal: Repair and overhaul a small engine properly and safely.
2. Specific:
 - a. List advantages for repairing and overhauling a small engine.
 - b. Demonstrate principles and procedures of good workmanship.
 - c. Follow a systematic method of repairing and overhauling a small engine.

B. Review Teaching Material

1. Service and Repair Instructions. Milwaukee, Wisconsin: Briggs and Stratton Corporation, 1982.
2. Small Engines, Volume I and II. 4th edition. Athens, Georgia: American Association for Vocational Instructional Materials, 1979.

C. Special Arrangements

1. Materials Needed
 - a. Several small engines in need of repair
 - b. Several sets of recommended tools
 - c. Several copies of repair and overhaul procedures
2. Shop or laboratory with suitable tables or benches

II. Presentation of Lesson

A. Motivation

1. Demonstrate to students the proper procedure for:
 - a. Inspecting and checking the cylinder bore of a small engine
 - b. Reizing cylinder bore to the next oversize
 - c. Refacing valves and seats
 - d. Checking and adjusting valve tappet clearance
2. Point out conditions that may cause future trouble if not adjusted or repaired.
3. Show students how to use the parts manual.

B. Content Outline

1. Terms

- a. Repair -- To replace worn or defective parts.
- b. Overhaul -- To examine thoroughly for repair.
- c. Short Block Assembly -- A factory-built cylinder-block assembly which includes the crankcase, piston, piston rings, connecting rod, valves, cylinder, and camshaft. It comes ready for one to add the remaining parts, such as the magneto, cylinder head, carburetor, and starter. The cost is approximately one half that of a new engine, completely assembled, and is approximately twice the cost of a new crankshaft.
- d. Inspect -- Visual inspection, looking for signs of wear, scoring, cracks, stripped threads, etc.
- e. Check -- Measure by means of plug gauges, feeler gauges, micrometer, scale, etc.
- f. Test -- Analyze with proper testing equipment.
- g. Replace -- This usually means to take off the old part and reassemble it or replace with a new one.

2. Advantages of repairing and overhauling a small engine:

- a. Personal satisfaction in the understanding of parts, function, and operating principles of the small engine
- b. Knowledge of the procedures to follow in repairing and overhauling small engines
- c. Savings of time and money by judging whether various assemblies can be economically repaired or whether they should be replaced

3. Principles and procedures of good workmanship:

Any job is best done by using a systematic approach.

- a. Obtain the various operator's repair, or service, and parts manuals. Study these to learn as much as possible relative to the engine being repaired.
- b. Arrange for a clean work area to ensure a longer-lasting repair job. Dirt and grit left on engine parts when reassembled cause wear.

- c. Use a table or bench to do the work. It is more comfortable and helps to keep tools and parts clean and organized.
 - d. Provide plenty of light above the work area.
 - e. Use an engine stand to hold the engine while it is being repaired.
 - f. Lay out the proper tools, materials, and equipment before starting the job.
 - g. Clean the engine before attempting to repair it.
 - h. Locate and record the numbers of the engine model, serial, and type.
 - i. Use a recommended procedure for disassembling the engine, being careful to lay the parts out in order of their removal. This helps in the systematic evaluation of the various engine components.
 - j. Use the parts manual to look up part numbers and cost of the various parts needed.
 - k. Determine if the engine should be repaired or a short-block assembly purchased.
 - l. Order parts or a short-block assembly as soon as possible. Compare new parts with old parts to ensure that they will work properly.
 - m. Make necessary engine repairs.
 - n. Reassemble engine according to specification.
4. The overhaul procedure:

The overhaul procedure which follows is intended to help one become accustomed to a systematic method of repairing Briggs and Stratton engines. Naturally these steps could be rearranged in different order, but efficiency is obtained when the repair operations are performed in the same sequence every time. The exact procedure will vary according to the engine model being repaired.

The overhaul procedure can also be used as an index. For information on how to perform most operations listed, refer to the page number or operation. Be careful to locate the instructions covering the specific model being repaired.

Note that some items do not apply to the engine model being disassembled.

Record the results of your observations in the space provided on the work sheet. If an item is to be replaced, place an "X" in the box. When the disassembly section has been completed, use the parts manual to find the reference and parts numbers as well as the cost. Total the cost on the second sheet and use it to estimate the feasibility of repair.

REVIEW: Repair and Overhaul Procedure Laboratory Worksheet

C. Suggested Student Activities

1. Overhaul a small engine.
2. Repair specific small engine assemblies.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 1: Farm Buildings

I. Preparation for Instruction

A. Objectives

Terminal: Identify types of farm buildings and demonstrate basic construction procedures.

B. Specific:

1. Identify and describe the basic types of farm buildings.
2. Discuss the importance of properly constructed farm structures.
3. Describe the foundation used in construction of farm structures.
4. Demonstrate construction procedures for walls and foundation.
5. Discuss the types of floors to be used in farm structures.
6. Determine types of doors to use on farm buildings.
7. Demonstrate the procedure for installing and hanging a walk-through door.
8. Identify the various types of roofing material for farm buildings.
9. Demonstrate application of various roofing materials.

B. Review of Teaching Material

1. Utility Buildings - Designs, Materials, Plans. Athens, Georgia: AAVIM, 1974.
2. Feirer, J. L. and G. R. Hutchings. Carpentry and Building Construction. Peoria, Illinois: Charles A. Bennett Co., Inc., 1981.

C. Special Arrangements

1. Contact local lumber companies for a field trip to examine various building materials.
2. Obtain all materials needed for construction of a small utility building.

D. Materials Required

1. Secure all available hand and power tools necessary for construction of a small utility building.
2. Obtain lumber roofing, siding, doors, and fasteners for the building to be built by students in suggested student activities.

II. Presentation

A. Motivation

1. Illustrate to the students the difference in cost between being able to construct buildings oneself and hiring someone to construct them.
2. Show the students some nice structures or projects that have been built. Discuss with them how they can build similar structures with their knowledge of some basic building procedures.

B. Content Outline

1. Types of farm buildings

a. As to use

- 1) Barns
- 2) Machinery and equipment sheds
- 3) Poultry houses
- 4) Livestock stalls and sheds
- 5) Pump houses and well sheds
- 6) Farm homes

b. As to structure (Transparency VII-1-A)

- 1) Shed-roof (lean-to)
- 2) Gable-roof
- 3) Gambrel-roof
- 4) Half-arch
- 5) Full-arch

2. Importance of properly constructed buildings:

- a. Ensure proper joint construction for strength in structural members to avoid sagging, leaning, and sway-back structures.
- b. Foundations are essential for elimination of unnecessary shifting of structural members.
- c. Proper grade of lumber or structural material prevents early breakdown of farm structures.

3. Foundations and walls

a. Types of foundations

- 1) Pole type -- In this type of construction the end of the pole and concrete casement form the foundation. Poles are usually set four to six feet deep. In soft soils, an eight inch footing of concrete is poured into the hole first to prevent sinking. A hole 20 inches in

diameter is sufficient to provide space for the pole and concrete casement. (Transparency VII-1-B)

- 2) Light-wood-frame construction -- This type of construction uses a continuous-poured concrete in concrete-block foundation. This will carry the weight of the building. Normally, footings are twice as wide as the thickness of the foundation wall. These footings should be poured to a point below the frost line in the soil to prevent movement of the building. It is necessary to anchor the building to the foundation by fastening the sill to the foundation with anchor bolts placed in the concrete before it has dried. The wall framing (studs) is then toe-nailed to the sill using 10 or 12 penny nails. These studs are usually put on 16 inch centers. (Transparency VII-1-C)
- 3) Post-and-pier construction -- This construction involves pouring a concrete footing and pier. The post is attached to the pier with a steel U-strap. (Transparency VII-1-D)
- 4) Masonry walls -- This construction practice involves using concrete blocks to construct the entire wall. With this method, the top plate is anchored to the wall with bolts long enough to reach through the plate and two courses of blocks. These must be embedded in concrete. (Transparency VII-1-E)
- 5) Steel frame -- Steel framing is used primarily as packaged metal buildings. Many farm structures are now being constructed by metal building contractors.

b. Protection measures

- 1) Any wood products touching the ground or used in moist conditions should be pressure treated to resist decay.
 - 2) For wood frame construction, wooden members should be at least 18 inches from the ground. This keeps wood dry and enables one to see termite tunnels.
4. Application techniques for studded wall construction following the pouring of the foundation:

- a. Lay the 2x4's that will be used for the top and bottom plates in position on the exterior walls, one beside the other. (Transparency VII-1-F)
- b. Attach the sole plate to the foundation.
- c. Mark stud placement on 24-inch or 16-inch centers.
- d. Remove the top plate and place it 8' from the sole plate on the foundation or subfloor.
- e. Face the marks toward the sole plate and nail the stud to the top plate by driving two 16d nails through the top plate. (Transparency VII-1-G)
- f. Push loose ends of assembled wall against the sole plate.
- g. Brace and toe-nail studs to the bottom or the sole plate with 8d nails, two to each side of the stud.
- h. Plumb all walls using a level and then brace the wall to maintain the plumb.
- i. Nail a 2x4 on the top plate overlapping joints at the corners to tie the walls together. (Transparencies VII-1-H and I)

5. Floors in Farm Structures

a. Types

- 1) Crushed rock
- 2) Concrete
- 3) Wooden

b. Selection

- 1) Crushed rock holds dirt and grease and makes it hard to roll or move equipment. It also is unsuited for shops or livestock facilities.
- 2) Concrete is easy to clean and is an excellent base for equipment and tools. It is usually less costly than wood floors and is excellent for livestock. However, a person can tire easily while working on a concrete floor. It should slope 1/8 inch per foot toward an access door. A 6-inch floor is recommended for machinery use. Other uses require a 4-inch

floor. Put down gravel fill before pouring the concrete to prevent cracking and keep the floor dry. (Transparencies VII-1-J and K)

- 3) Wood floors — Wood floors would be restricted to human use or in buildings such as pump houses and well sheds. They are not well suited for livestock or equipment.

c. Construction procedure -- This will be given for wooden floors since concrete floors simply require form construction and pouring.

- 1) After the foundation and footing have been laid, place the sill (2x6) on the foundation and attach with 1/2" anchor bolts spaced six feet to eight feet apart. Insulation material and a metal termite shield may be placed between the sill and the foundation. (Transparency VII-1-L)
- 2) A post and girder must be constructed to provide support for the floor joists. These girders must be flush with the sill plate to act as a bearing for the joist. (Transparency VII-1-M)
- 3) On the sill, lay out the desired floor joist spacing. These should be 16-inches on center. (Transparency VII-1-N)
- 4) Allow for the thickness of the joist material for header joist to be placed flush with the outside edge of the sill.
- 5) When two joists overlap a girder, allow a four-to six-inch overlap and nail the two joists together at the point of overlap. (Transparency VII-1-M)
- 6) Bridging is then installed to stiffen floor frames and assist an overloaded joist. This is placed between the joists. There is diagonal and solid bridging. (Transparency VII-1-O)
- 7) Completed structure with flooring applied (Transparencies VII-1-P and Q)

6. Doors (Transparency VII-1-R)

a. Types

- 1) Sliding doors -- These doors slide on a metal track and can be made to fit an opening of size.
- 2) Over-head doors -- These doors are commonly used for garages. They only fit certain openings, however, measuring 8, 9, 10, 15, or 16 feet in width. They are usually 7 feet high. They become difficult to handle if larger than 10x16 feet.
- 3) Walk-through door -- These doors are the type that people encounter everyday when entering or leaving houses or businesses. They come in various sizes ranging from 24" to 36" wide. Doors are purchased as exterior or interior doors. Exterior doors are for exposure to weather, while interior doors are used inside buildings. Most of these doors are six feet eight inches tall. Interior doors are 1 3/8-inches thick while most exterior doors are 1 3/4-inches thick.

b. Installation procedure (Transparency VII-1-S)

- 1) Before installing a door frame, prepare the rough opening in the stud wall to receive the frame. The rough opening should be three inches higher and 2 1/4-inches wider than the size of the door. Place cripple studs between the header and top plate to ensure proper wall support over the door frame. (Transparency VII-1-S)
- 2) Set the doorframe in the rough opening. Interior doorframes are made up of two side jambs, a head jamb, and stop moldings that the door closes against. The jamb widths are usually 4 1/4-inches or 5 1/4-inches. Many doorframes now are prefabricated; however, one may build a doorframe easily.
- 3) Once the doorframe is in place, plumb the frame jamb placing shingle wedges between the side jamb and the stud. The hinge jamb is usually plumbed with four or five sets of wedges for the height of the frame. Two 8d finishing nails are driven at each wedged area. Make sure the frame is plumb and level in the rough opening. If it is not, the door will not hang properly. (Transparency VII-1-T)
- 4) Door trim or casing is nailed to both the jamb and the framing studs or header. Allow 3/16

inch edge distance from the face of the jamb. Use 6d or 7d finishing or casing nails on the thick part of the trim and 4d nails on the thin part. Most trim is 2½-inch to 3½-inch in width. Casing with molded trim must have mitered corners. (Transparency VII-1-U)

- 5) To hang the door on the frame, fit the door into the frame with clearances of 1/8" at the top and door knob side, 1/16" on the hinge side, and ½" at the bottom. Two 3½-inch by 3½-inch loose-pin butt hinges are used to hang the door. The top hinge is placed seven inches from the top of the door and the bottom hinge is placed 11 inches from the bottom of the door. Exterior doors usually have three hinges. Use a ½" chisel to remove wood to allow the hinges to be recessed in the door and into the frame. (Transparency VII-1-V)
- 6) Installation of hardware such as doorknobs is explained on the packaging of these items.

7. Roofing

a. Types of materials (Transparency VII-1-W)

- 1) Asbestos-cement sheets -- This is made of asbestos fiber and portland cement. They come in shingles and corrugated sheets and must be handled carefully when installing. They are fire resistant and heat reflective.
- 2) Galvanized steel -- This roofing comes in sheets of varying thicknesses depending upon the gage of the metal. Twenty-eight gage or heavier is recommended for farm buildings. It comes in widths up to four feet and lengths up to 24 feet. The amount of galvanizing (two inch coating) on the surface of the roofing determines how long it will be before rust begins to appear. It is preferable to get a coating of two ounces or more per square foot. This will be stamped on the roofing. (Transparency VII-1-X) Be especially careful when selecting metal roofing in order to get proper provision for overlapping joints to prevent leaking. Some now have covered drain channels ahead of nailing ridge to prevent leaking. Aluminum roofing is also available and provides for long life and neat appearance.
- 3) Asphalt shingles and roll roofing -- This type of roofing is laid so that shingles overlap and

cover each other to shed water. These shingles are sold by the "square" which will cover about 100 square feet of roofing area. These are most commonly used on farm dwellings. Roll roofing is made of the same material but is more commercial; however, it is less attractive.

- 4) Selvage-edge roll roofing -- Roofing of this type is coated with asphalt and mineral granules. It is installed by rolling the roofing across the length of the roof. Each successive run should overlap the previous run by about one-half the width of the roofing. This will ensure two-ply coverage which gives more durability and wind resistance. Be sure to get the type used with cold cement (mastic).

b. Selection factors

- 1) Life expectancy
- 2) Fire resistance
- 3) Hail resistance
- 4) Resistance to heat from sun
- 5) Wind resistance
- 6) Maintenance
- 7) Minimum roof slope for application

c. Installation procedure for metal roofing:

- 1) Apply purlins or nailing strips to rafter framing. These should be spaced 16 inches to 32 inches apart. (Transparency VII-1-Y)
- 2) Cut sheet to length and nail through the tops of the ribs using 1 3/4" screwshank nails with neoprene washers to prevent leaks.
- 3) The eave should have about a 2 1/2-inch overhang.

d. Installation procedure for square-butt strip shingles (3 tabs) (Transparency VII-1-Z)

- 1) Apply underlayment (15 lb. asphalt saturated felt) to the roof decking (sheathing) by starting at the eave line and rolling it across the roof. There should be a top lap of at least two inches and a four inch sidelap at all

end joints. This should cover the entire roof. Use roofing nails or special nails made for felt to attach it to the roof decking until shingles can be applied.

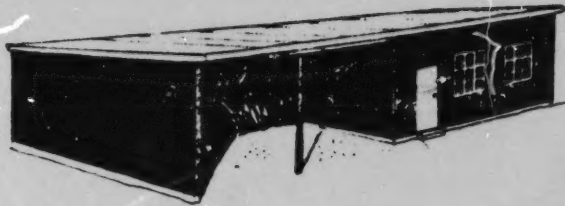
- 2) Attach metal drip strip around edges of the roof over the felt.
- 3) Begin starter course of shingles with inverted shingles. Then apply next course on top of starter course. (Transparency VII-1-AA)
- 4) Apply courses so that each shingle is breaking joints on halves. This is shown in Transparency VII-1-AA.
- 5) Use galvanized roofing nails to apply shingles so that five inches of the course below the one being applied are showing. (Transparencies VII-1-AA and BB) The four nails are placed 5/8-inch above the top of the cutouts in the shingles and located horizontally with one nail one-inch from each end and one nail on the center line of each cutout. (Transparency VII-1-Z) A chalk-line can be laid to keep the application of each course straight. This line would be five inches above the top of the course below.
- 6) Apply the ridge shingles by cutting each tab from the shingles. Bend each tab or shingle lengthwise down the center with an equal amount of shingle on each side of the ridge. Again, use a five-inch exposure. Each nail is secured 5½-inches from the exposed end.

C. Student Activities

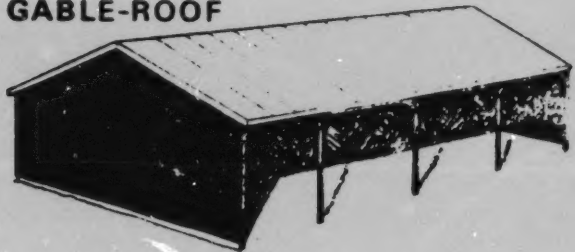
The students can construct a small utility building (8'x12') using the procedures discussed in the lesson. It is suggested that students work in groups of four, but the number is left to the discretion of the teacher. Afterward, these buildings can be sold.

TYPES OF FARM BUILDINGS

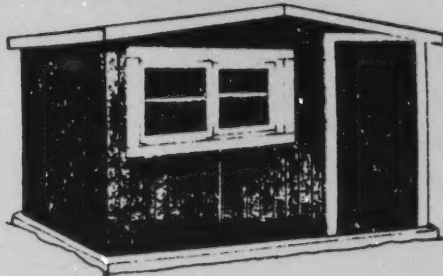
SHED-ROOF



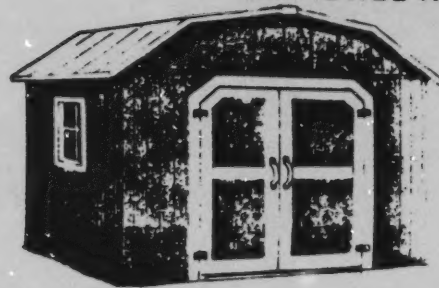
GABLE-ROOF



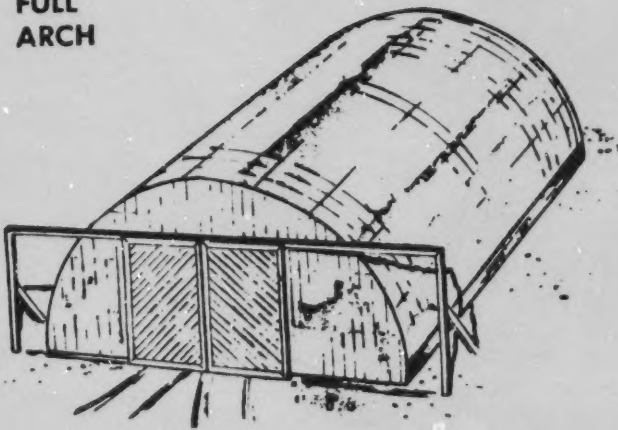
GABLE-ROOF



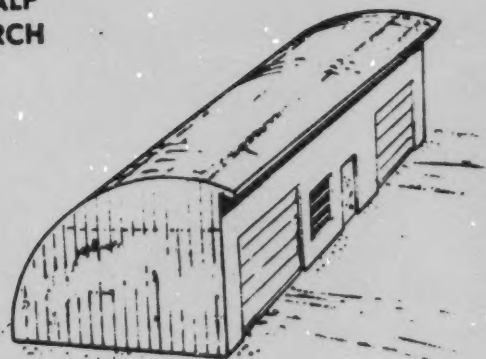
GAMBREL-ROOF



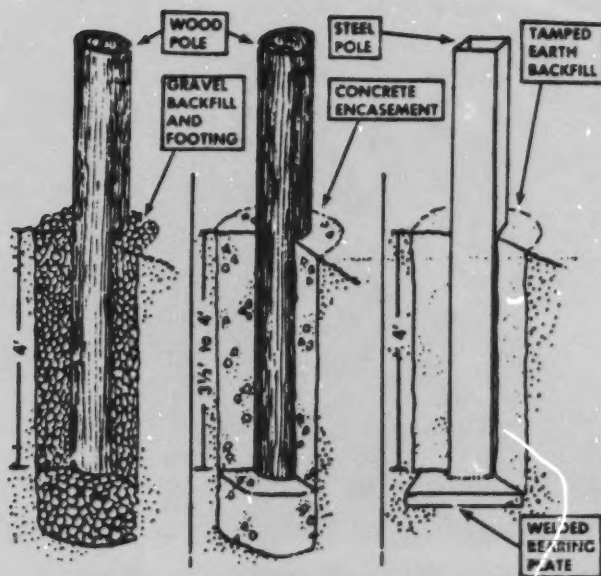
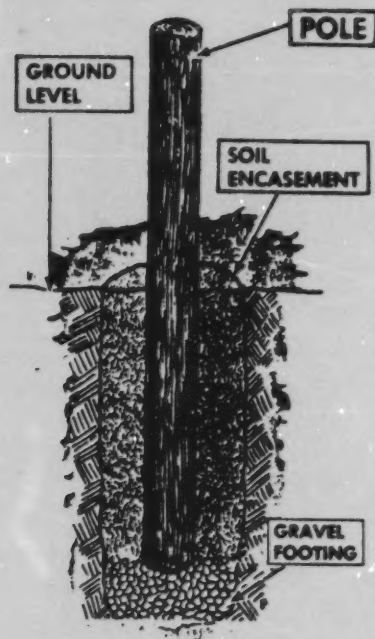
FULL
ARCH



HALF
ARCH

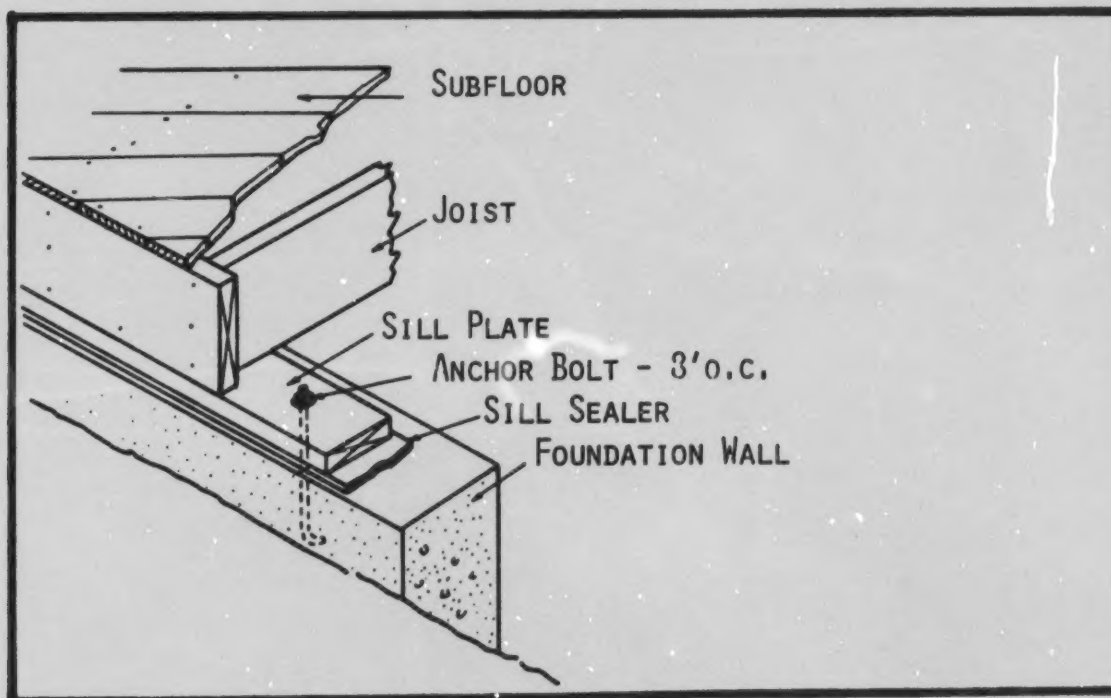
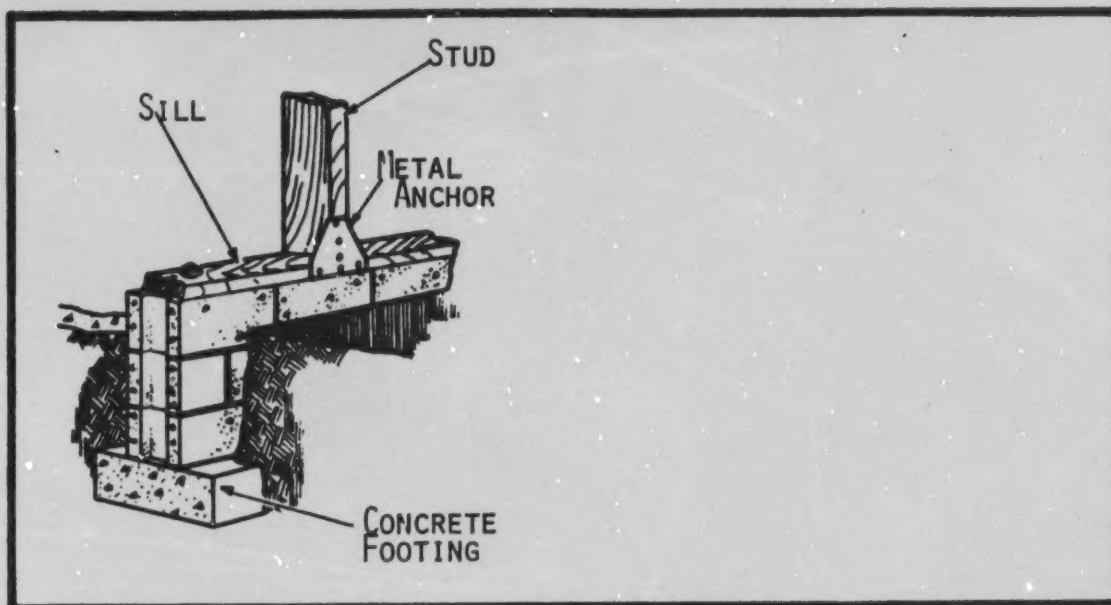


POLE-TYPE FOUNDATION



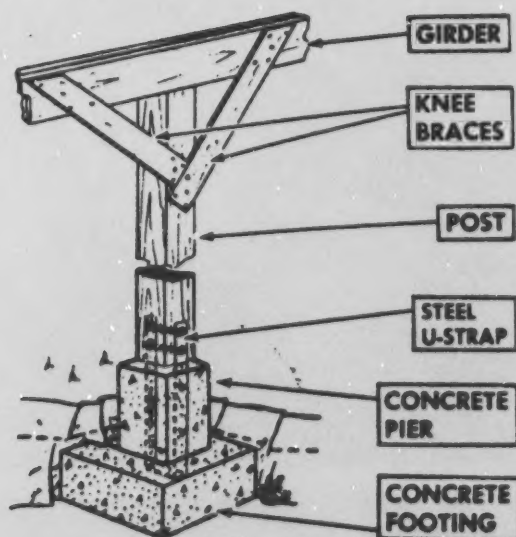
TRANSPARENCY VII-1-B

LIGHT-WOOD-FRAME CONSTRUCTION FOUNDATION

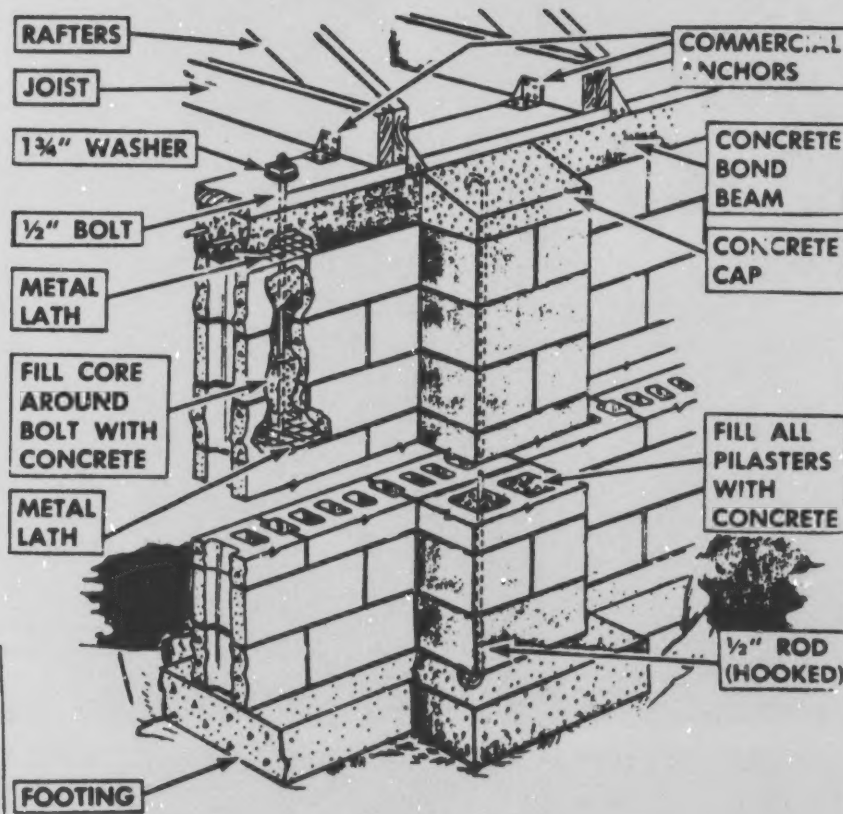
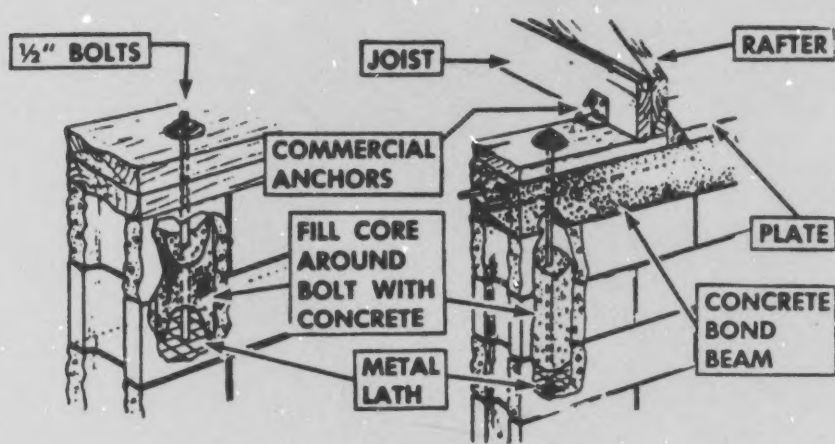


TRANSPARENCY VII-1-C

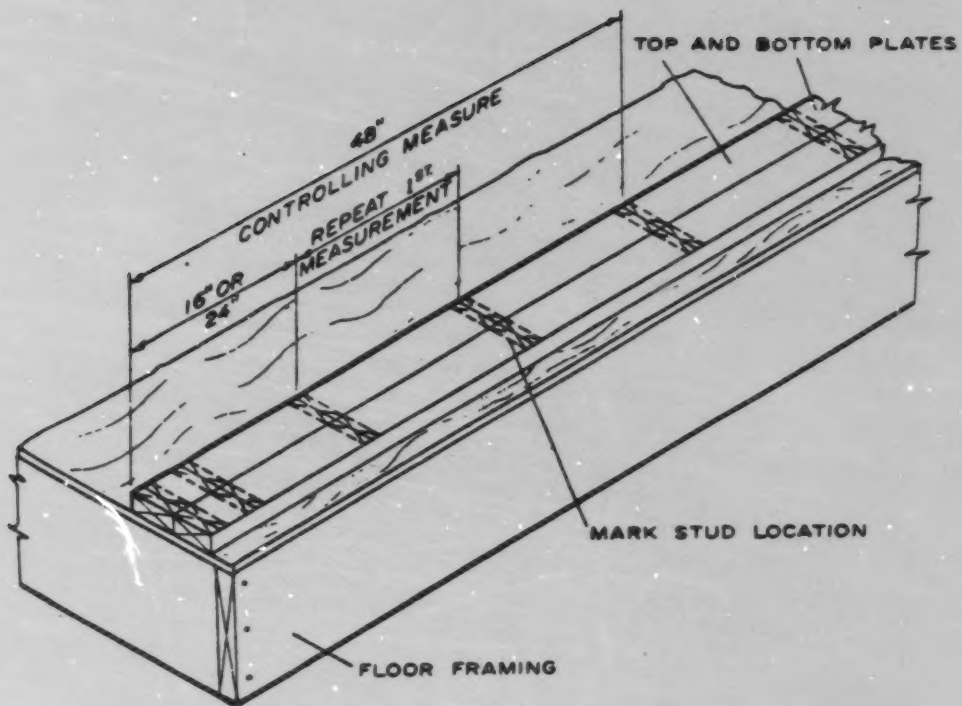
POST-AND-PIER CONSTRUCTION FOUNDATION



MASONRY WALL CONSTRUCTION

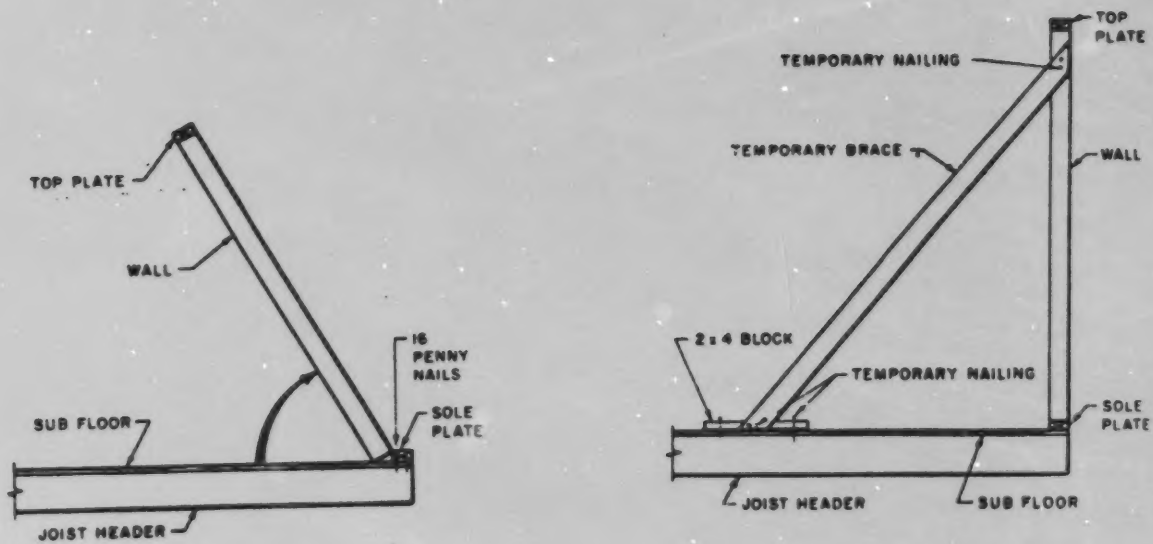
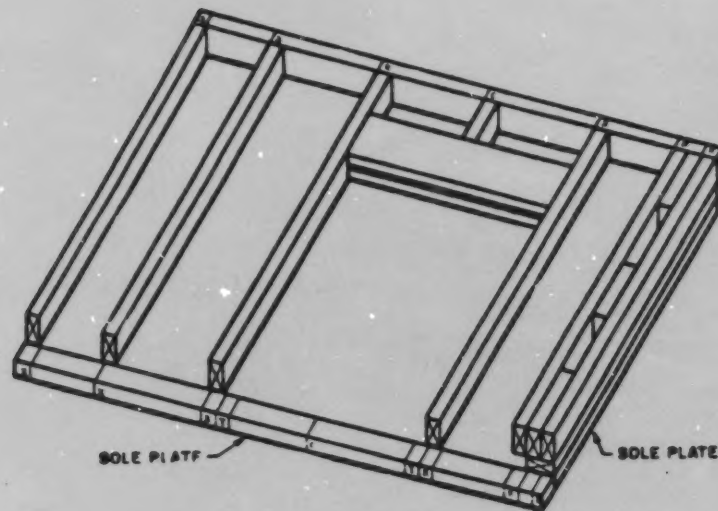


MARKING STUD LOCATION



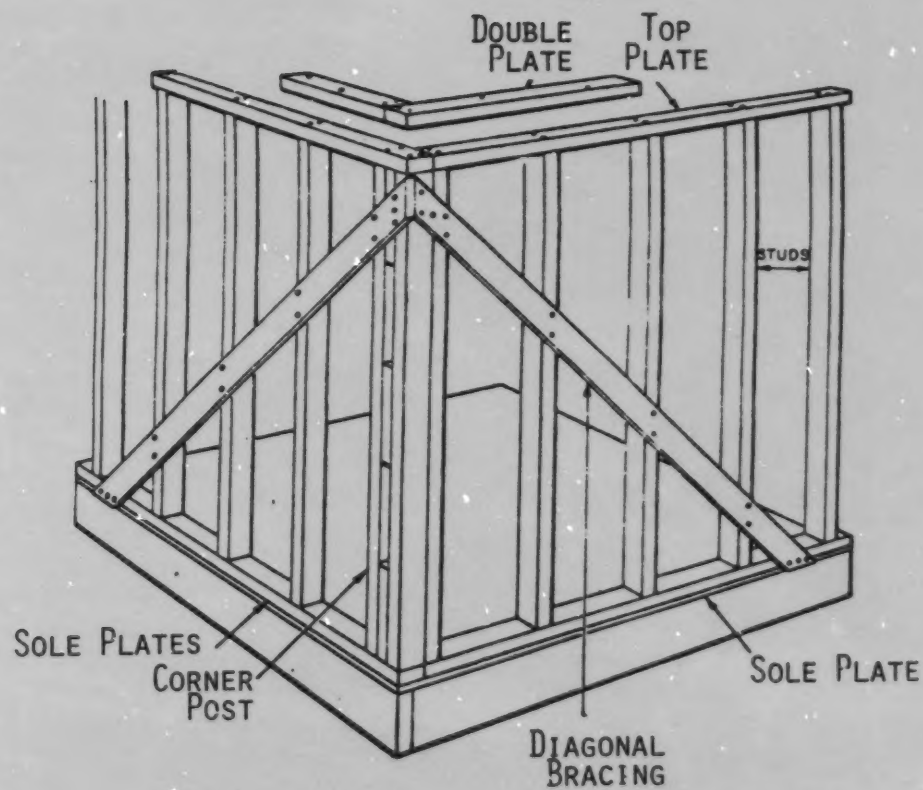
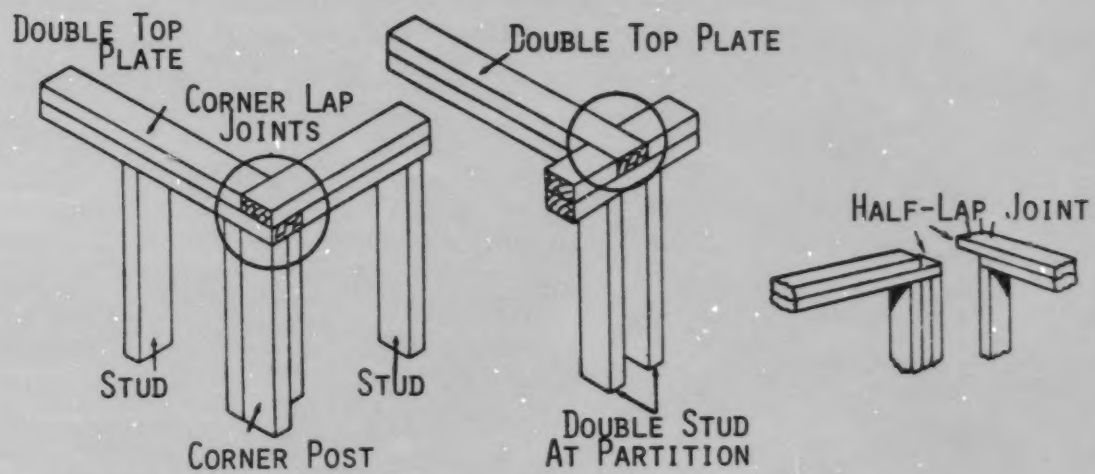
TRANSPARENCY VII-1-F

WALL ASSEMBLY AND PLACEMENT

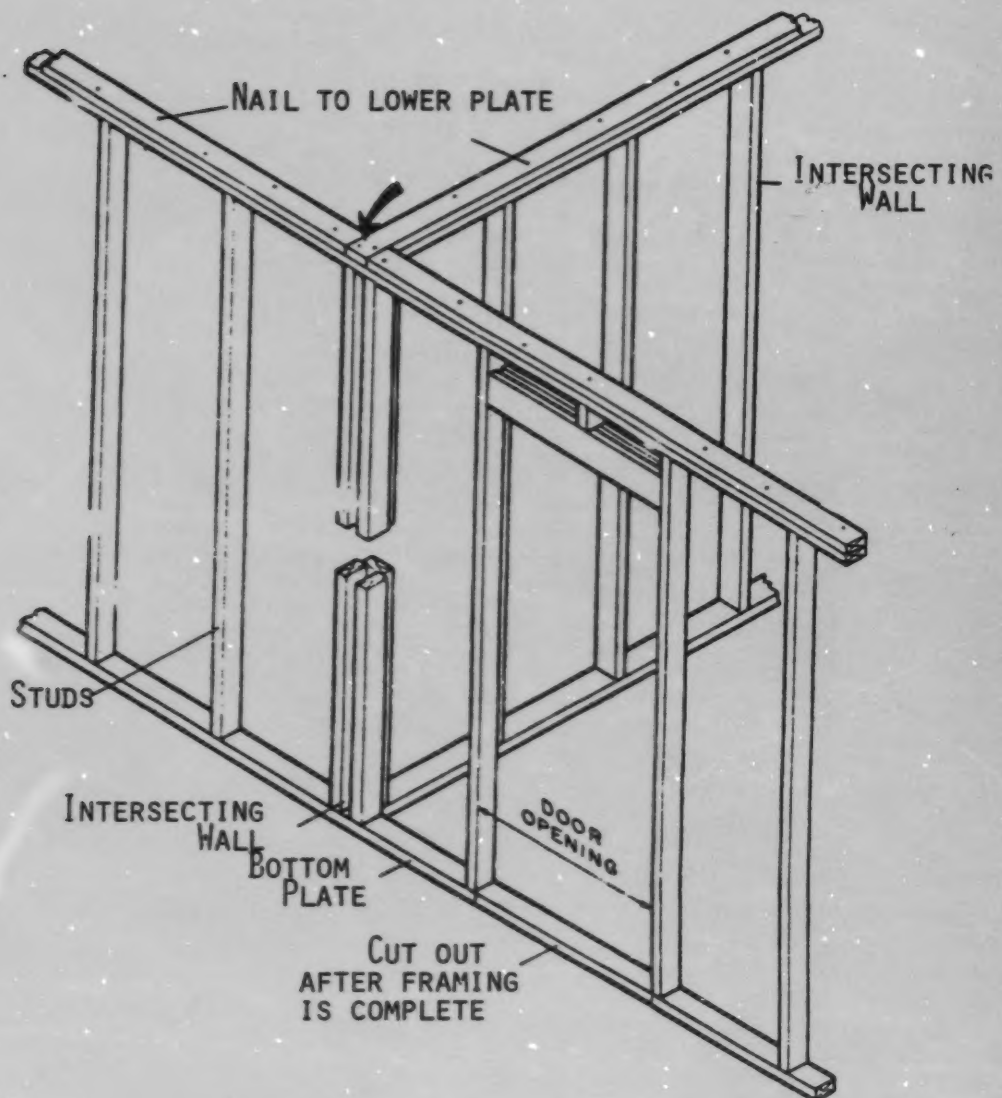


TRANSPARENCY VII-1-G

ATTACHMENT OF DOUBLE TOP PLATE

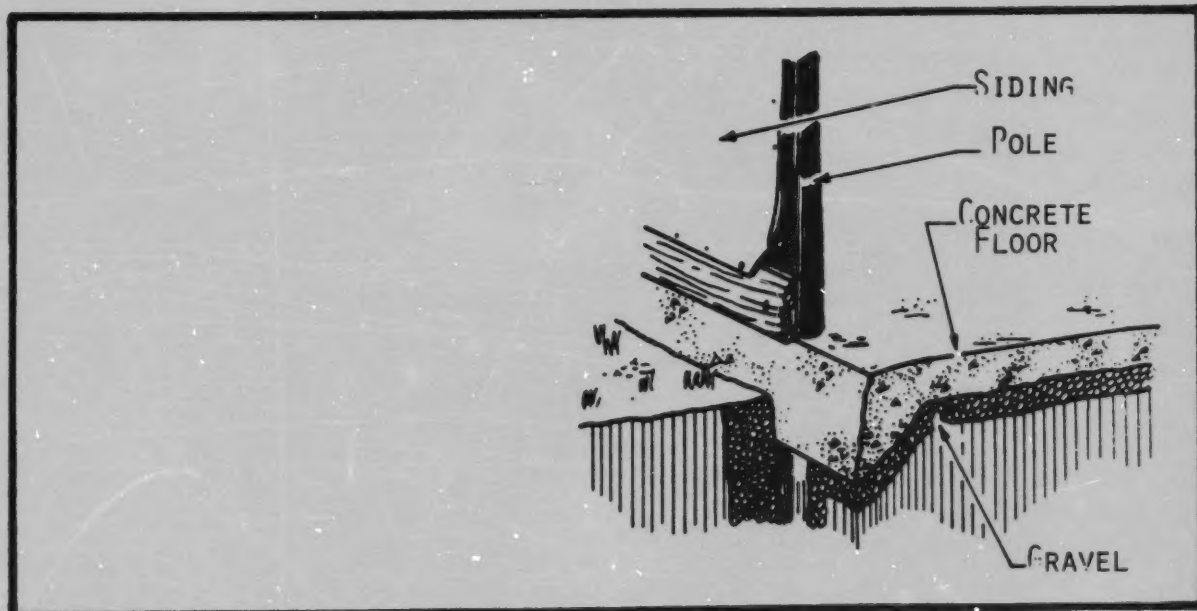
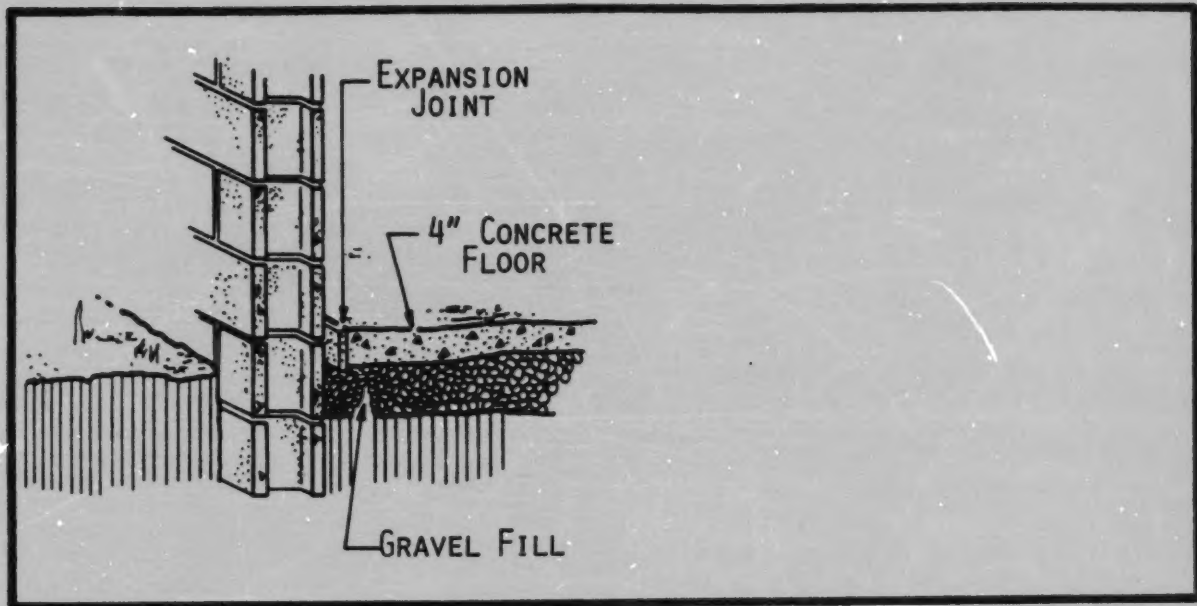


ATTACHMENT OF DOUBLE TOP PLATE



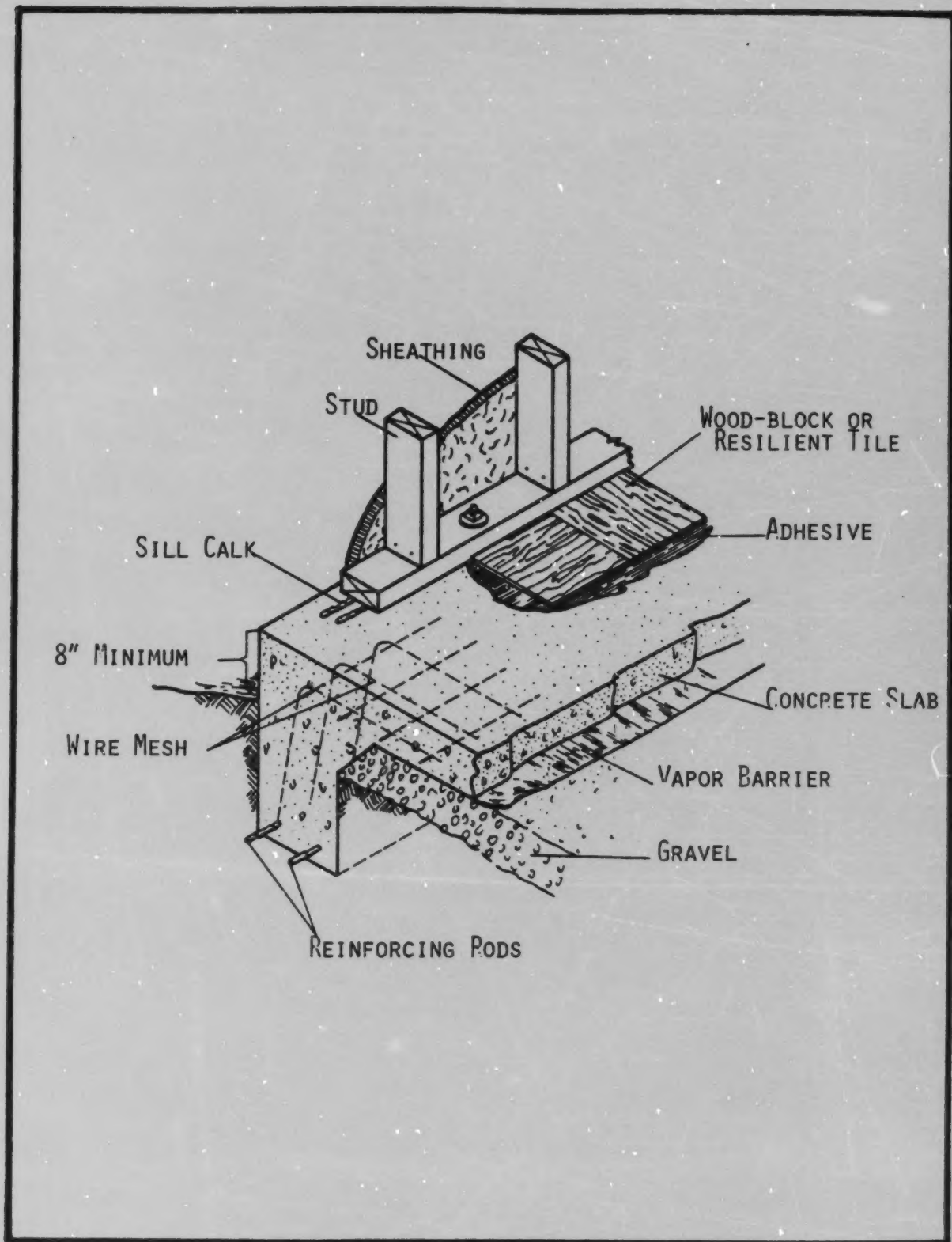
TRANSPARENCY VII-1-I

CONCRETE FLOORING

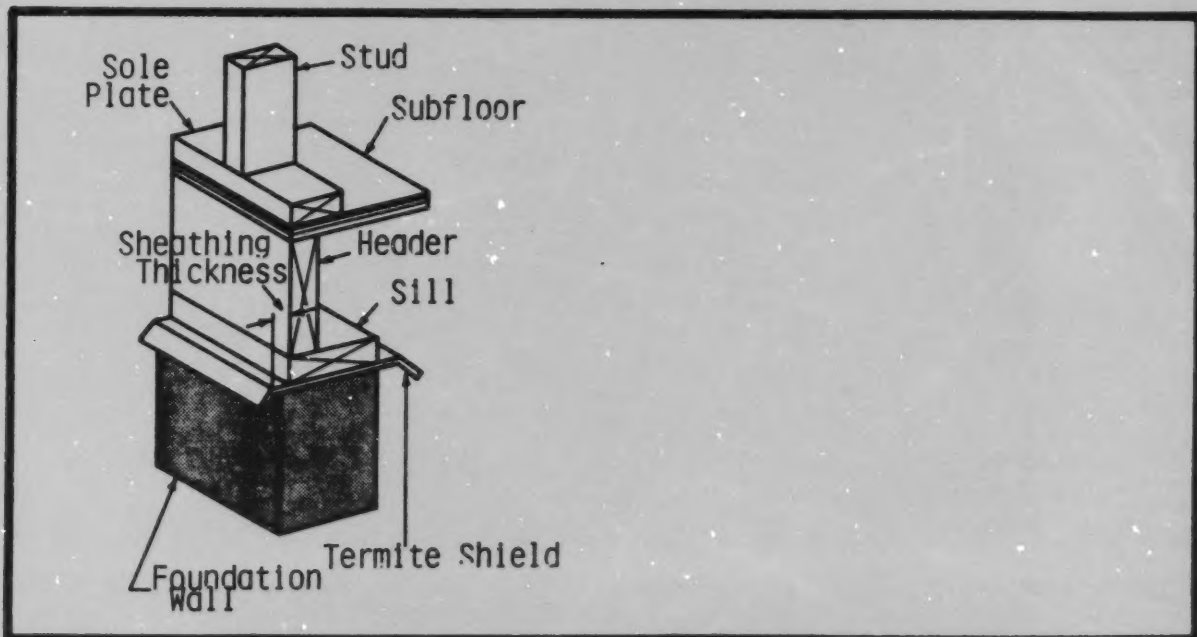
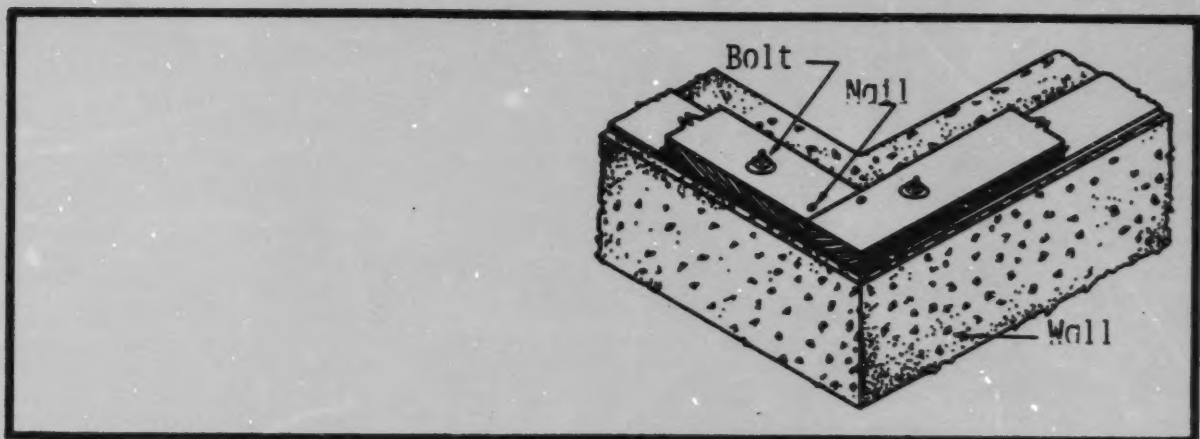
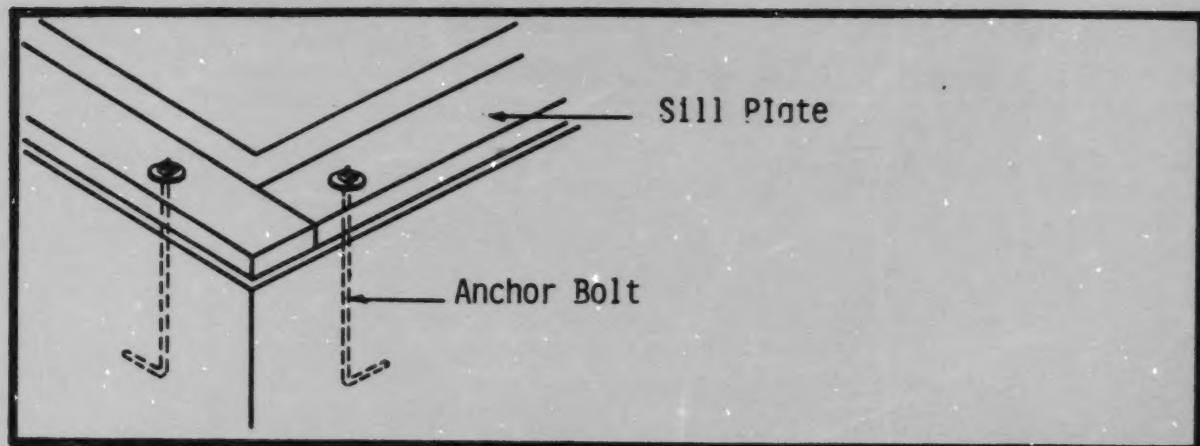


TRANSPARENCY VII-1-J

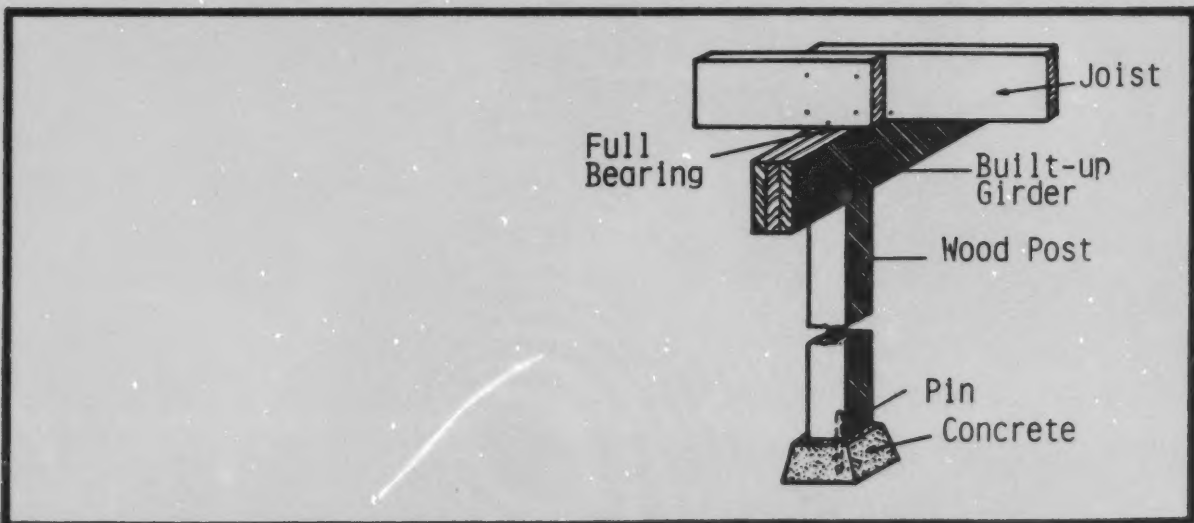
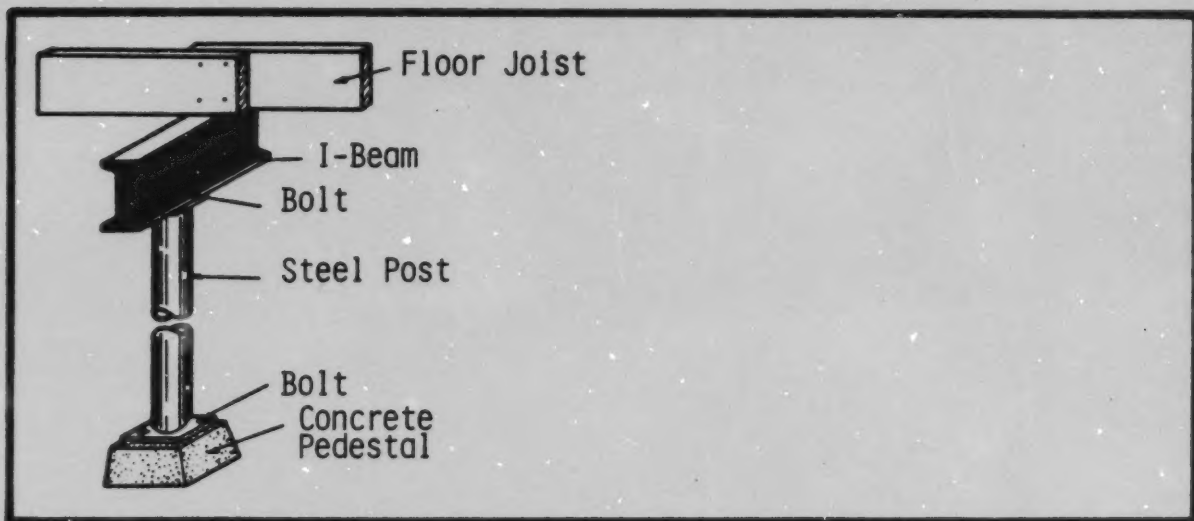
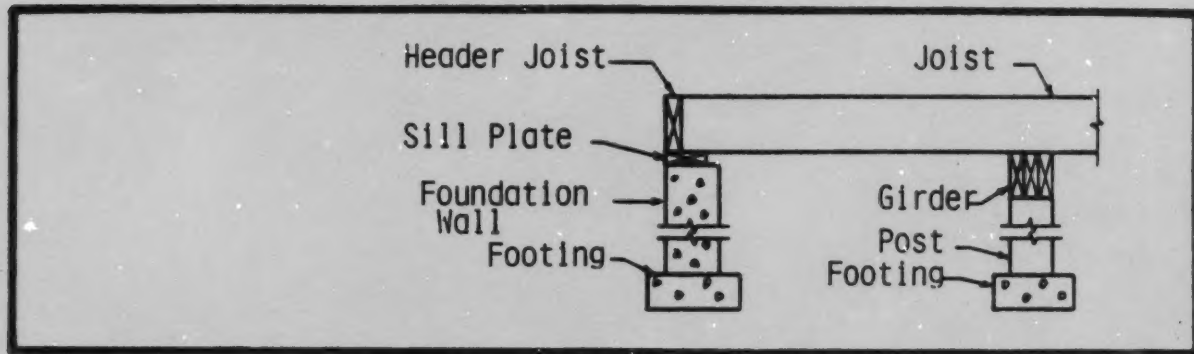
CONCRETE FLOORING



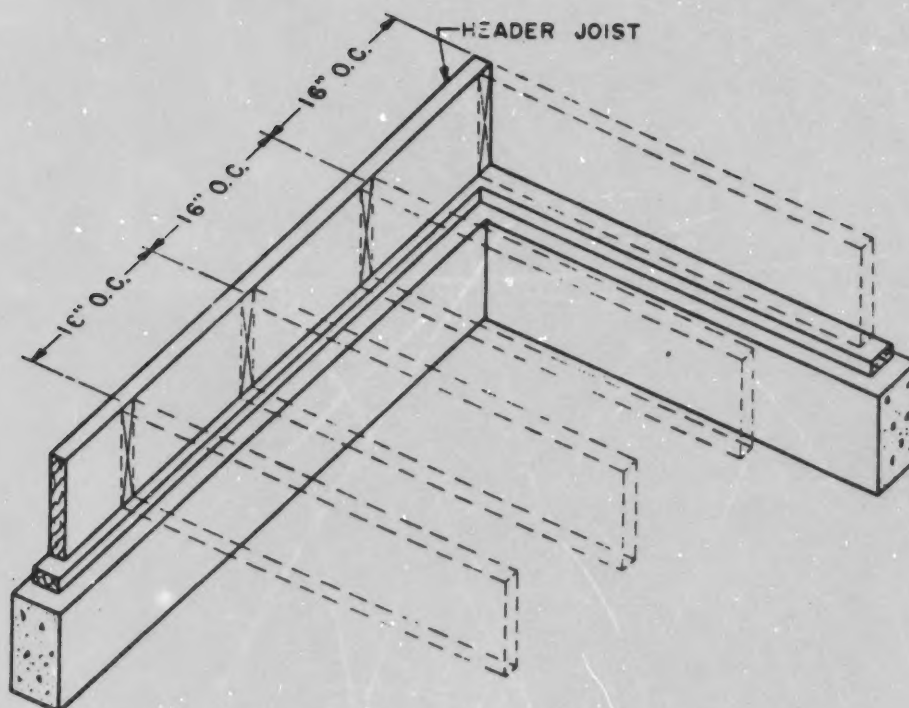
ATTACHMENT OF SILL TO FOUNDATION



POST AND GIRDER CONSTRUCTIONS

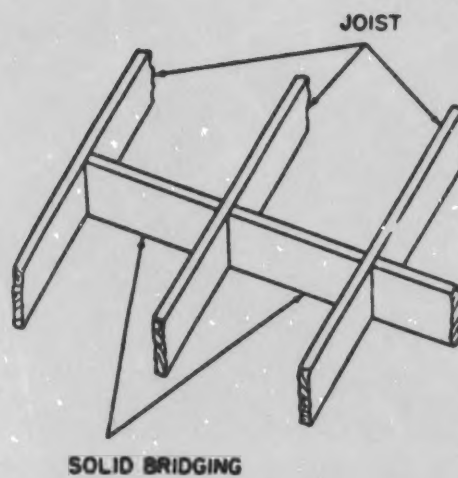
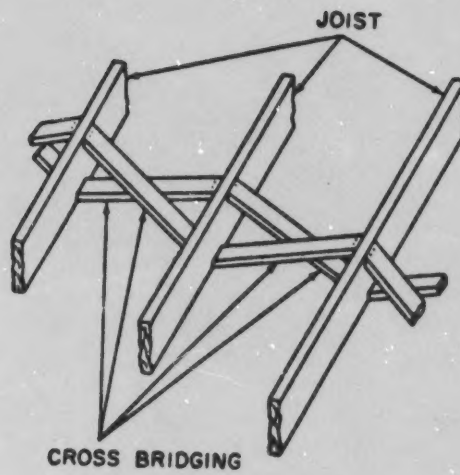


JOIST LAYOUT ON SILLS

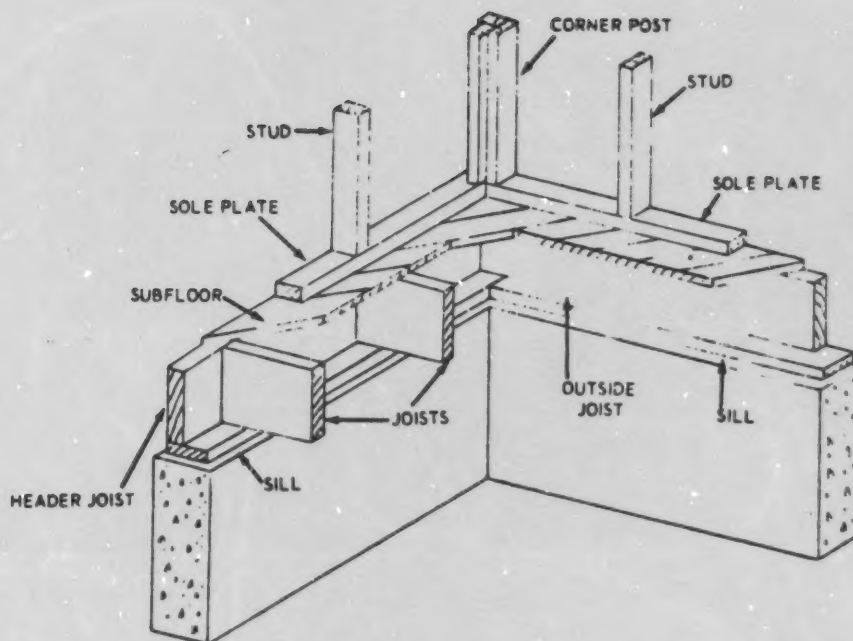
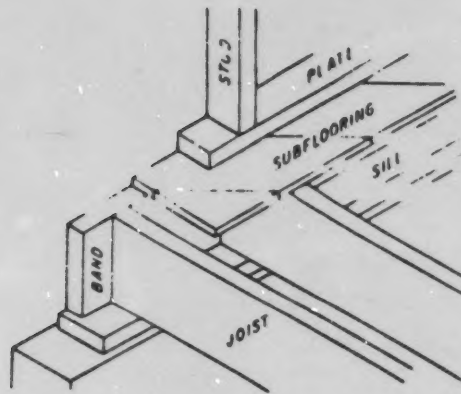


TRANSPARENCY VII-1-N

JOIST BRIDGING

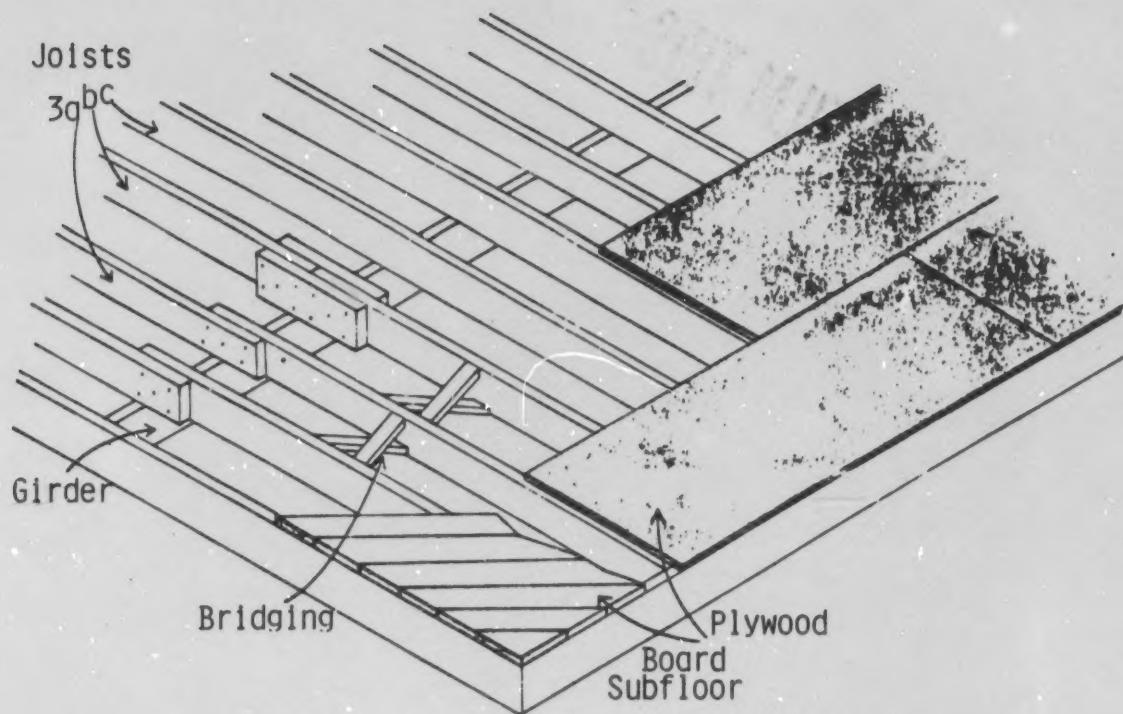


ISOMETRIC VIEW OF COMPLETED FLOORING



TRANSPARENCY VII-1-P

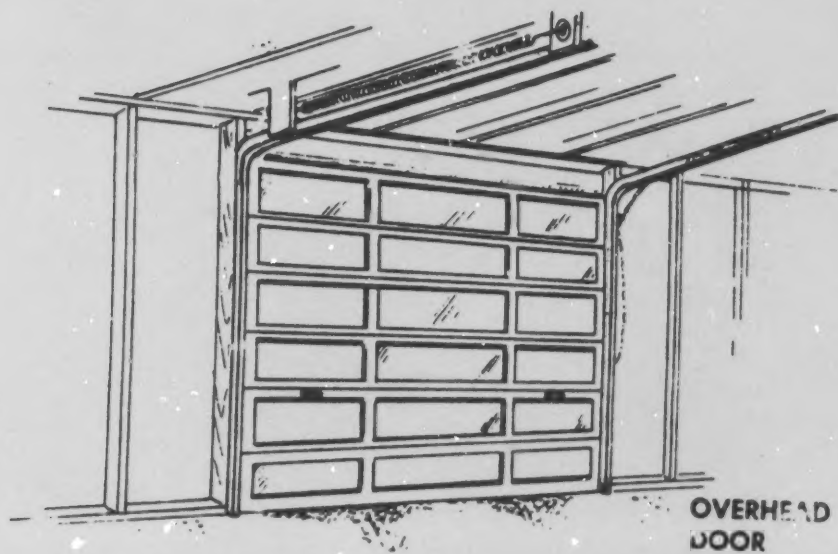
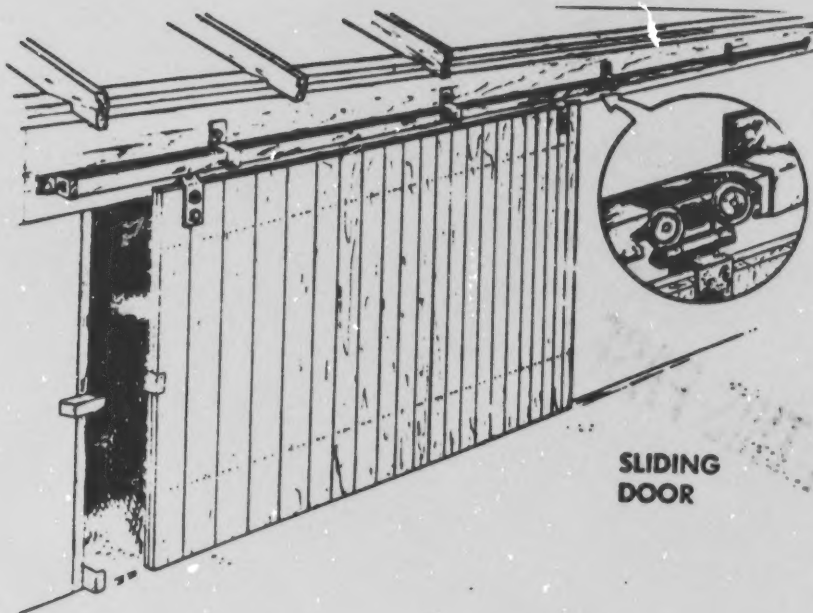
COMPLETED FLOORING



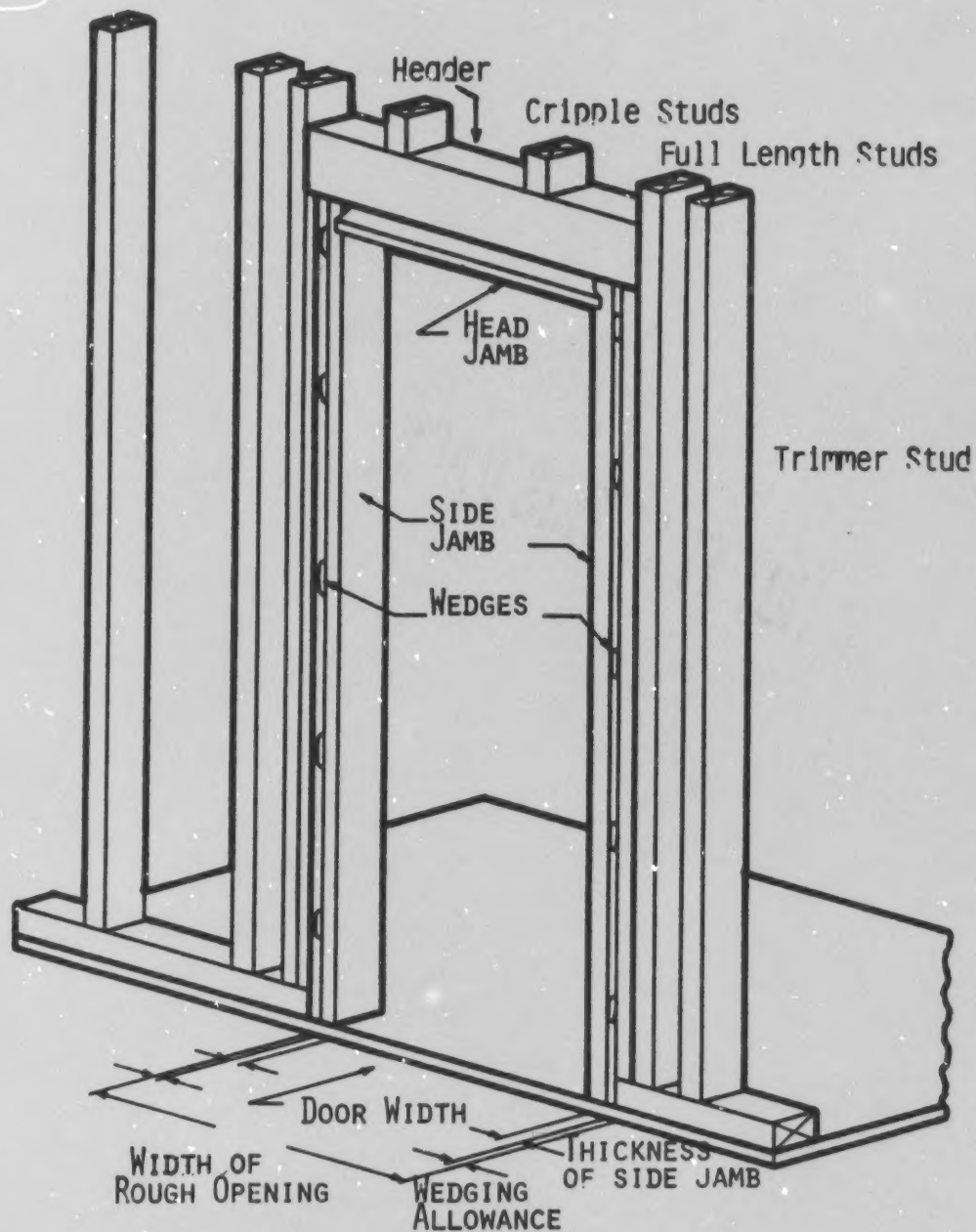
- 3a Lapped
- b Butt-Joined
- c Full Length Joists

TRANSPARENCY VII-1-Q

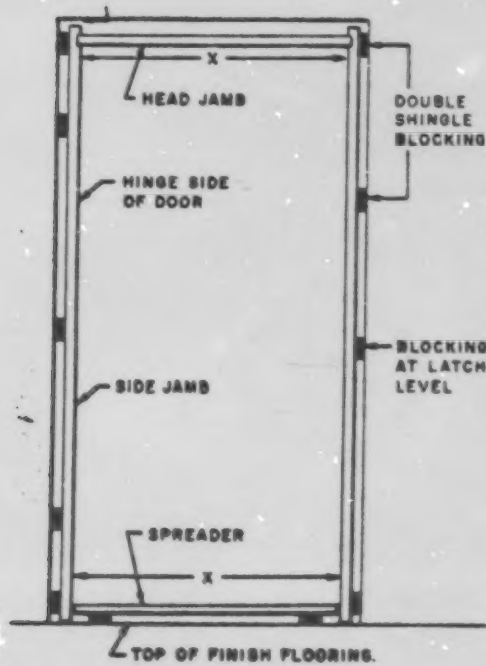
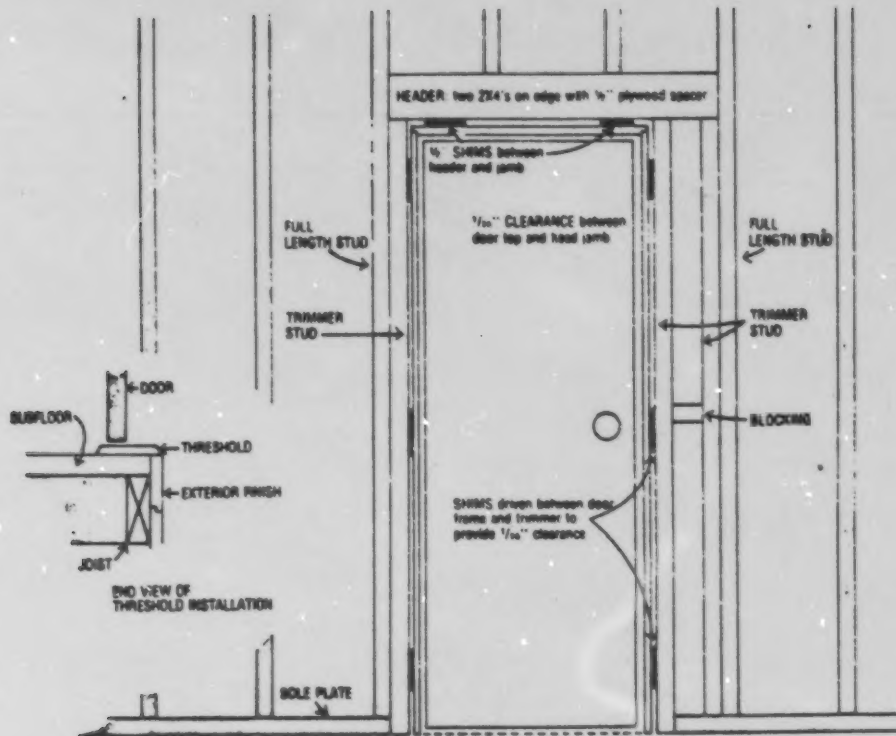
DOOR TYPES



ROUGH DOOR OPENING WITH JAMB INSTALLED

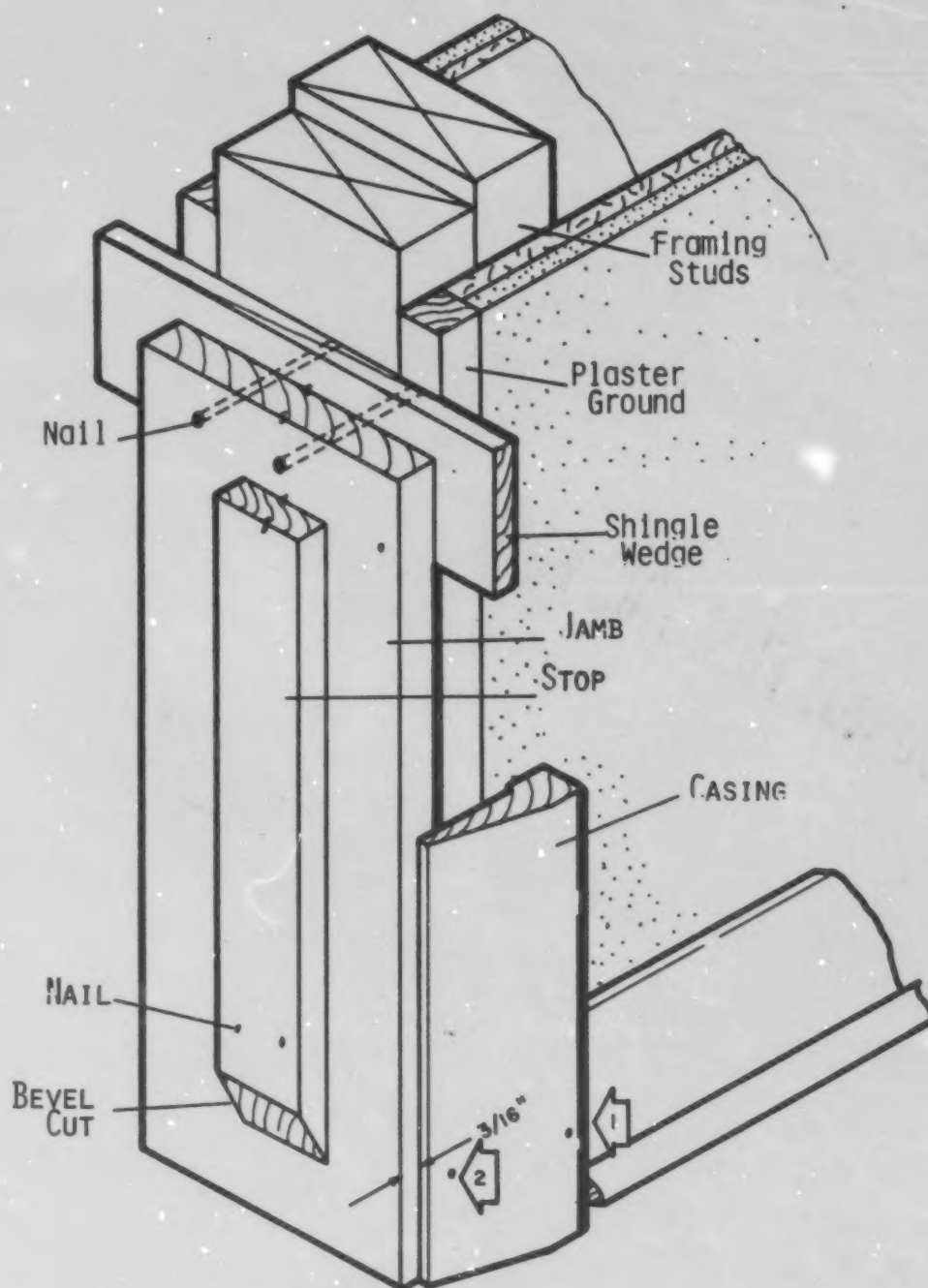


PLACEMENT OF DOOR FRAME

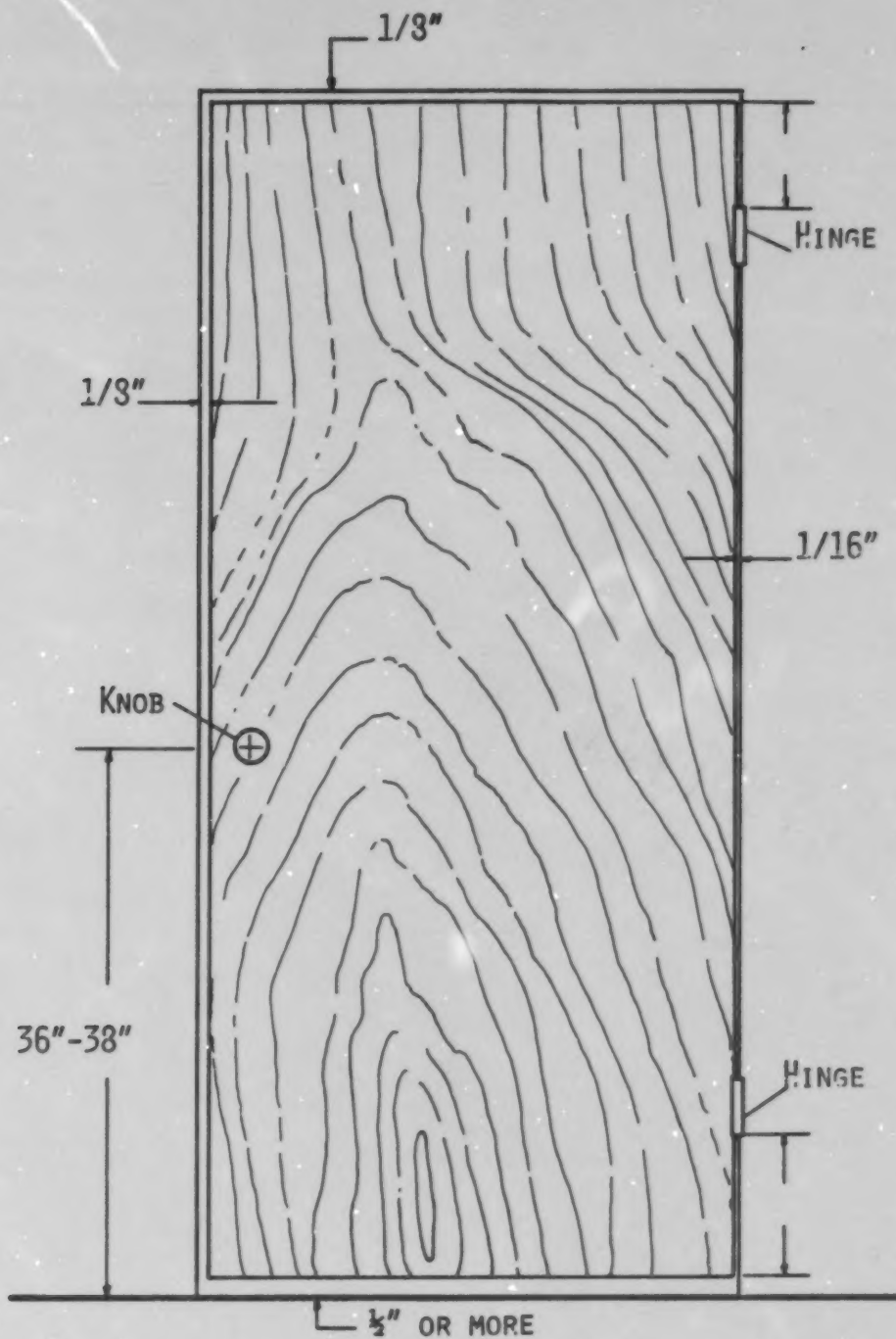


TRANSPARENCY VII-1-T

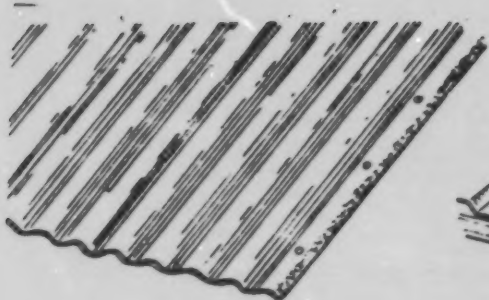
VIEW OF DOOR FRAMING



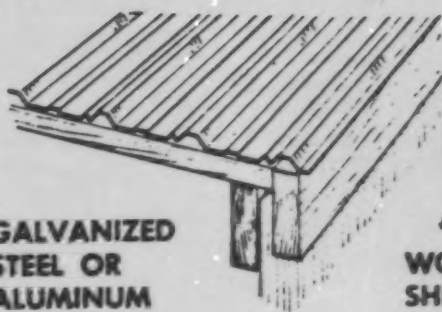
DOOR CLEARANCES



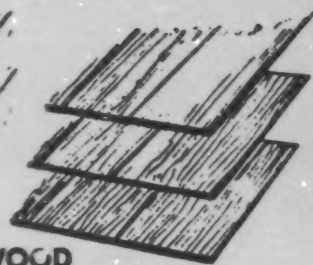
TYPES OF ROOFING MATERIALS



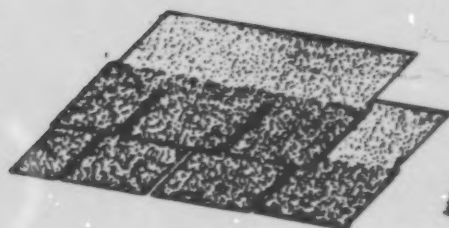
**ASBESTOS-CEMENT
SHEETS**



**GALVANIZED
STEEL OR
ALUMINUM**



**WOOD
SHINGLES**



**ASPHALT
SHINGLES**

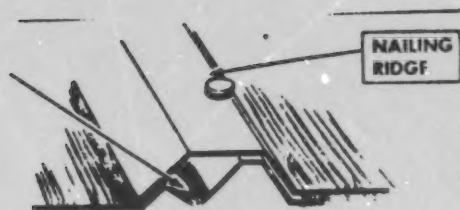
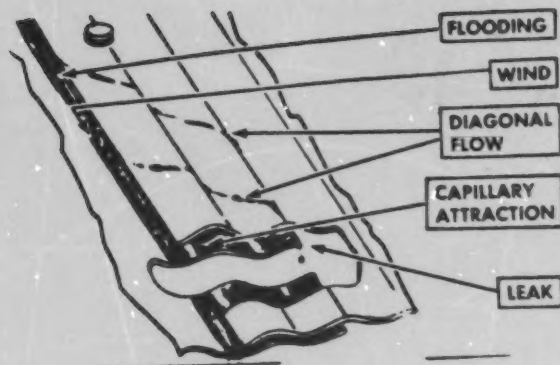


**SELVAGE-EDGE
(MINERAL SURFACE)
ROLL ROOFING**



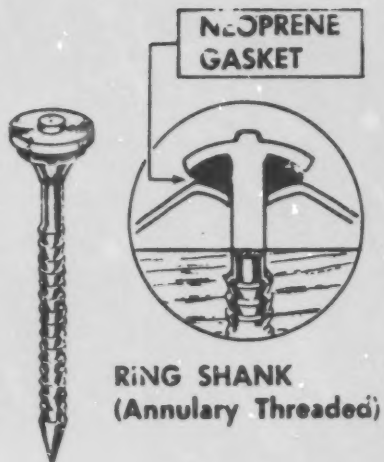
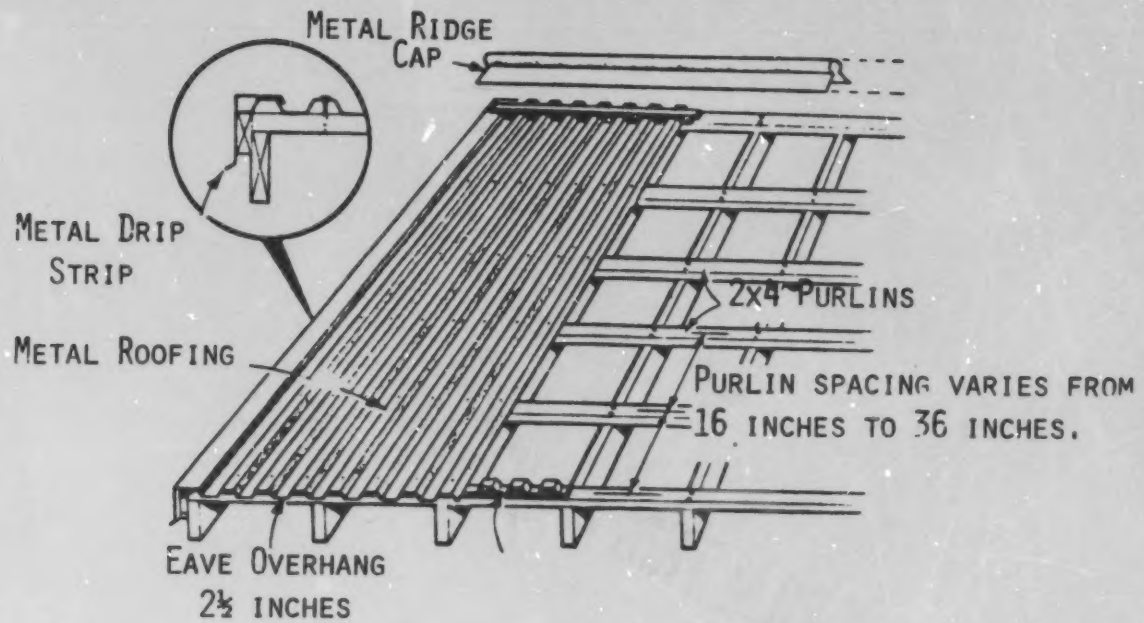
**SMOOTH-SURFACED
ROLL ROOFING**

METAL ROOFING TO PREVENT LEAKS



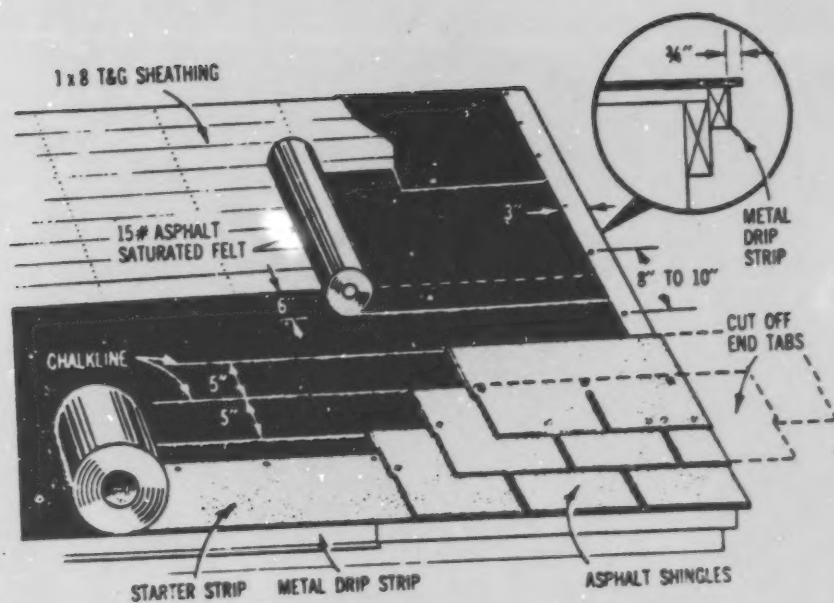
TRANSPARENCY VII-1-X

INSTALLATION OF METAL ROOFING

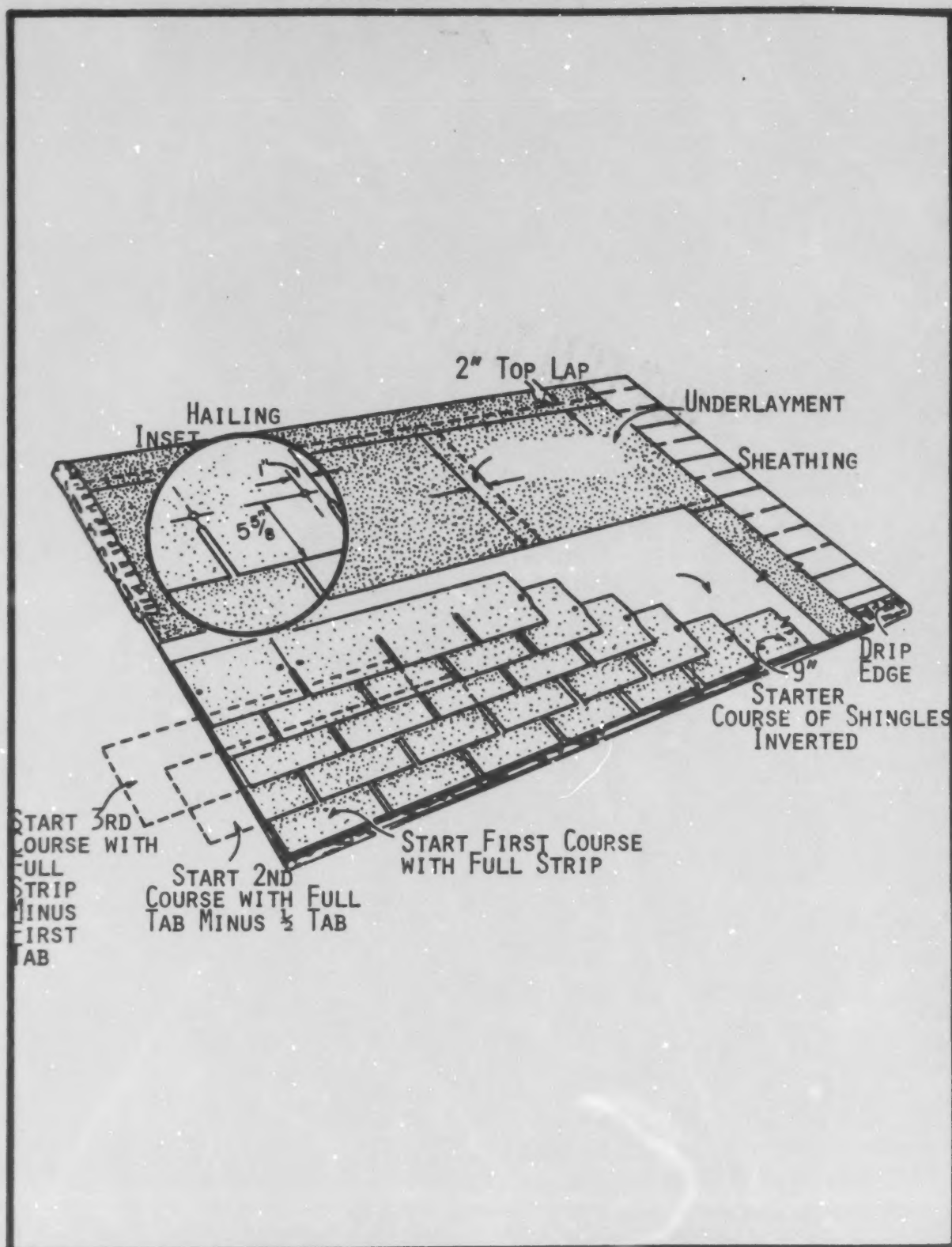


TRANSPARENCY VII-1-Y

APPLICATION OF UNDERLAYMENT AND SHINGLES

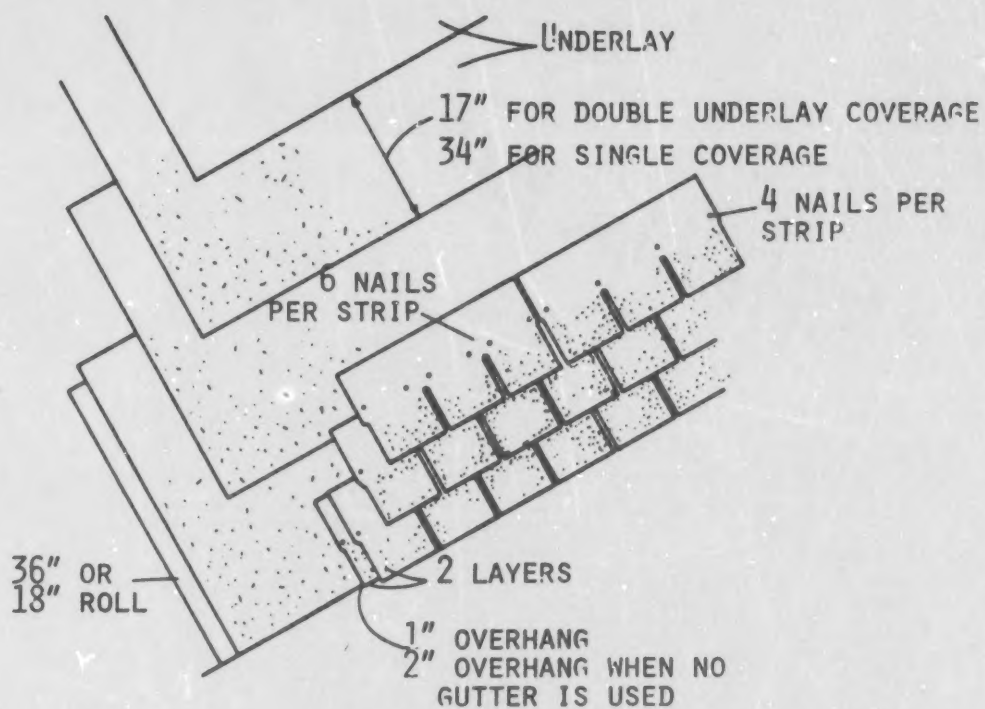


ATTACHMENT OF SHINGLES



TRANSPARENCY VII-1-AA

PLACEMENT OF SHINGLE NAILS



TRANSPARENCY VII-1-BB

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 2: Farm Fencing

I. Preparation for Instruction

A. Objectives

1. Terminal: Plan, identify, and construct farm fences.
2. Specific:
 - a. Discuss the purpose of farm fencing.
 - b. Select type of fencing materials to use.
 - c. Select types and sizes of corner and line posts.
 - d. Identify and select fencing fasteners.
 - e. Determine type of passageway to construct in fencing.
 - f. Construct a barbed wire fence.
 - g. Construct a welded wire fence.
 - h. Construct a board fence.
 - i. Construct a gate.
 - j. Construct an electric fence.

B. Review of Teaching Material

1. Building Fences. Athens, Georgia: AAVIM, 1974.
2. Planning Fences. Athens, Georgia: AAVIM, 1980.

C. Materials

1. Woven wire, barbed wire, treated posts and lumber, and steel posts
2. Fencing staples and nails

3. Post-hole diggers
4. Electric fence controller
5. Electric fence insulators

II. Presentation of Lesson

A. Motivation

1. Show pictures and illustrations of poor fencing and discuss the inconvenience, time lost, and money wasted in unnecessary repairs and chasing livestock that have broken through poor fences.
2. Allow students to tell experiences caused by poor fencing practices.

B. Content Outline

1. Purposes of farm fencing:

- a. Establish boundary lines
- b. Control animal diseases
- c. Crop and grazing rotation
- d. Farm appearance enhancement
- e. Livestock and breeding control
- f. Maintain relationship with neighbors
- g. Prevent straying of livestock

2. Types of fencing material:

- a. Barbed wire -- This fencing is made of two or more strands of smooth steel wire twisted together with two or four barbs every five inches. For a permanent fence five to six posts are required every 100 feet. (Transparency VII-2-A)
- b. Woven wire -- This is made of a number of horizontal wires separated by strands of vertical wires called stags. The spacing between the horizontal wires may vary from 1½ inches at the bottom to nine inches at the top. This type of fencing is marketed in light, medium, heavy, and extra heavy weights. Heavy weight fencing costs 25 to 50 percent more than lightweight. (Transparency VII-2-B)
- c. Board fence -- This fencing is usually made of strips of lumber four to six inches wide nailed on posts spaced eight to 10 feet apart. These are expensive to build and maintain.
- d. Mesh wire -- This is strong and safe for confinement of a variety of animals. There is a diamond-mesh and square-knot mesh wire. The joints are stiff and are hard to climb. (Transparency VII-2-C)
- e. Electric fence -- The purpose of this fence is to shock any animal that touches the fence so that it will stay away from it. It may be a one or two strand fence or one strand added to a permanent barbed wire or woven fence. The strand is connected to an electric fence controller. This is economical to construct. (Transparency VII-2-D)

3. Selection for use:

a. Cattle

- 1) Four or five strand barbed wire
- 2) Mesh or board fence

b. Hogs

Woven wire with one or more strands of barbed wire

c. Sheep and goats

Light and medium-weight woven wire

d. Horses

- 1) Woven wire
- 2) Mesh wire or board fencing
- 3) Do not use barbed wire.

4. Selection of anchor posts and line posts:

a. Anchor posts

- 1) Rosemont design -- Horizontal brace design with two to three span construction. The brace wires pull over two spans instead of one. (Transparelcy VII-2-E)
- 2) Cross-brace, double-span assembly -- This is a heavy duty design that attaches to a center post.
- 3) Steel diagonal-brace ends -- This is constructed by setting the corner post and the diagonal braces in concrete.
- 4) Braced-line-post assembly -- This in-line bracing is placed every 200 meters in extra long fencing. This wire provides a pull point for stretching new fence. (Transparency VII-2-F)

b. Line posts

- 1) Selection factors
 - a) Type of fencing material
 - b) How long one wants the fence to last

- c) Cost to set posts
- d) Kinds of posts available -- treated wood, concrete, steel, fiberglass
- e) Height of fence
- f) Lightening protection

c. Installation:

- 1) Lay out fence line by setting a stake (6') at each end of the proposed fence line. (Transparency VII-2-G)
- 2) Have someone proceed about 100 feet toward one end with another stake while another person aligns that stake with the stake at the other end. Then set stake.
- 3) Continue this every 100 feet until complete fence line is stake.
- 4) Set anchor-and-brace assemblies -- The assembly should be set to a depth of at least three feet six inches. (Transparency VII-2-H)
- 5) Install line posts by stretching cord, wire, etc. between two anchor post assemblies as a guide line. Space posts 16 feet apart for woven wire, 12 to 14 feet for barbed-wire fences, and five to eight feet for board fences. Line-post depth will depend on the type of post used.

5. Fencing fasteners (Transparency VII-2-I)

a. Qualities to consider:

- 1) Coating -- Galvanized-wire fasteners are most commonly used in all fencing because they last a long time.
- 2) Holding capacity -- For woven and barbed wire, a choice is made between U-shaped fence staples or L-shaped staples. These vary in length and holding capacity. The staple should be able to last as long as the post lasts.

b. Types

- 1) U-shaped and L-shaped staples
- 2) Wire clip for use with steel posts

- 3) Nails for use in board fences -- plain shank, fluted, helically threaded, annularly threaded

6. Passageway in fences:

a. Gates (Transparency VI-2-J)

- 1) Most gates are 52 to 54 inches high and are usually 14 to 16 feet wide depending on machinery width and use.
- 2) Gates can be wooden or metal (aluminum). Aluminum lasts longer but is less durable and more expensive than some wooden gates.
- 3) It is important to construct the gate so it will not sag and to mount all gates to a strong anchor-and-brace assembly.
- 4) Types of gates are double-brace, wood gate-steel bracing, wire-steel frame, and aluminum or steel.

b. Cattle-guards (Transparency VII-2-K)

- 1) Most cattle guards consist of a pit two feet deep, six to eight feet wide, and 10 to 16 feet long. Concrete or heavy planking is used to support the pipe or plank grating that is put on top to support traffic across the guard.
- 2) Cattle guards are not used when horses are involved. They can easily injure a leg.

7. Constructing barbed wire fences:

- a. After posts have been installed, attach one end of the wire to the end post. Unroll barbed wire to the next anchor post. (Transparency VII-2-L)
- b. Erect dummy post for attaching wire stretcher. This will allow the tightened portion of the fence to be attached to the anchor post so that little extra slack is there when stretches are removed. (Transparency VII-2-M)
- c. Attach line to wooden post by setting the staple crosswise to the grain to get better holding power. But, do not drive the staple up to the point that it crimps or damages the wire. Attach wire to steel posts using wire post clamps and then hammer the steel lug, if present, down over the wire. (Transparencies VII-2-N, VII-2-O, and VII-2-P)

- d. Wire spacings down the post vary according to the needs of the user. (Transparency VII-2-Q)
- e. Wire should be installed on the inside of the posts or on the side that will receive the most pressure against it.

8. Installing woven wire:

- a. Make sure fence roll is in proper unrolling position so that the close mesh end is next to post line. (Transparency VII-2-R)
- b. Attach one end of the wire roll to the post by removing one stay-wire from top to bottom. Put fence the desired height and staple to the anchor post. Extend the end of each line wire around post and wrap on itself. Unroll the rest of fence to the next post assembly. (Transparencies VII-2-S and VII-2-T)
- c. Stretch wire by erecting a dummy post for the same reason as used in stretching barbed wire. Attach two fence stretchers to the dummy post and clamp bar that is fastened to the fence. The clamp bar should be attached about opposite the anchor post. Tighten fence until 1/3 of tension curve on fence is removed. Do not over stretch. (Transparencies VII-2-U, VII-2-V, and VII-2-W)
- d. Attach woven wire to posts by using staples in wooden posts or post clamps with steel posts.
- e. Add barbed wire on top if needed.

9. Installing electric fences

- a. Wire for electric fences is generally smooth. However, barbed wire may be used.
- b. Attach wire to insulator on end post. Unroll wire along the length of the fence. (Transparency VII-2-X)
- c. Attach wire to insulators on line posts by wrapping wire around insulator or by using a short length of No. 12 or smaller galvanized wire. Stretch wire by hand to the next insulator. Complete entire fence in the same fashion.
- d. Electric controllers for the fence should be hooked up last. Three sources of power for controllers are 6-volt batteries, 12-volt batteries, or a 120-volt power supply. Durability and operation of electric fence controllers depends on:

- 1) Use of approved controller,
- 2) Good ground rod at the controller,
- 3) Good insulator,
- 4) Maintaining a clean fence, and
- 5) Providing lightening protection.

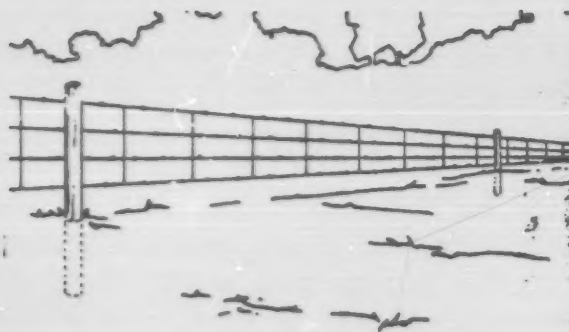
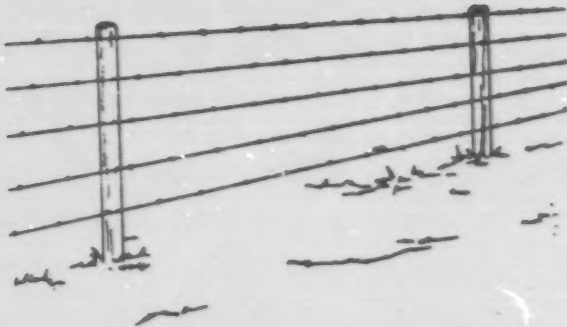
10. Installing a board fence

- a. After properly spacing and setting the treated posts, lay treated boards along the fence line. Place 16-foot board at top of first two spans for measure, then cut to proper length. Nail this board to all three posts with two nails in each post. (Transparency VII-2-Y)
- b. Measure the second board from the edge of the first post to the center of the second post. This keeps the joints from being on the same post. (Transparency VII-2-Z)
- c. Apply remaining boards in the same manner.
- d. Spacings between planks may vary depending on use. An example of spacing is seen in Transparency VII-2-Z.

C. Suggested Student Activities

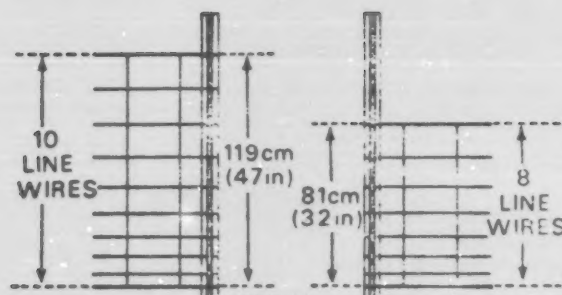
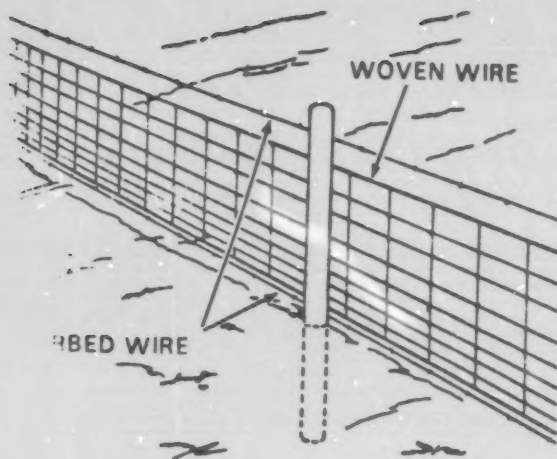
Set up a designated area around the vocational agriculture building in which students will construct the different types of fencing mentioned in the lesson. Each fence should be 20-30 feet long. The instructor will have to use discretion as to length.

BARBED WIRE TYPE OF FENCING



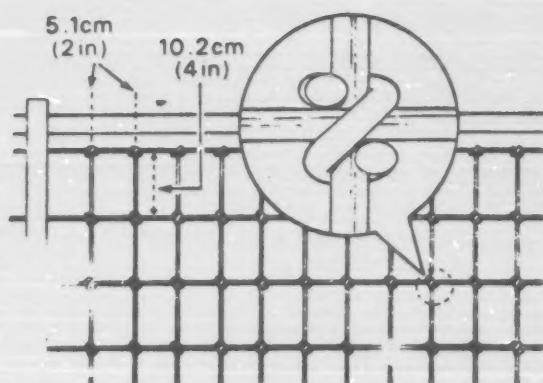
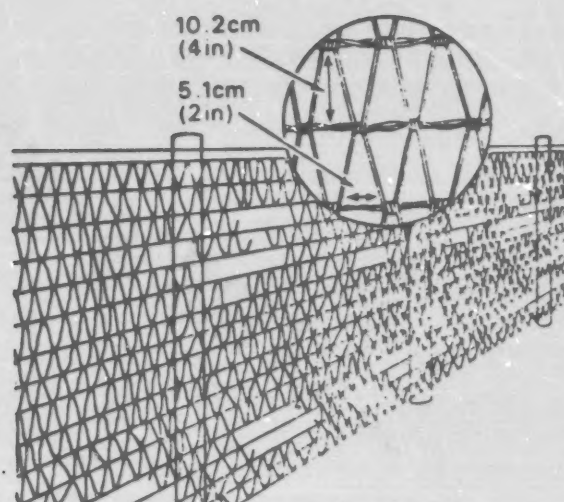
TRANSPARENCY VII-2-A

WOVEN WIRE TYPE OF FENCING



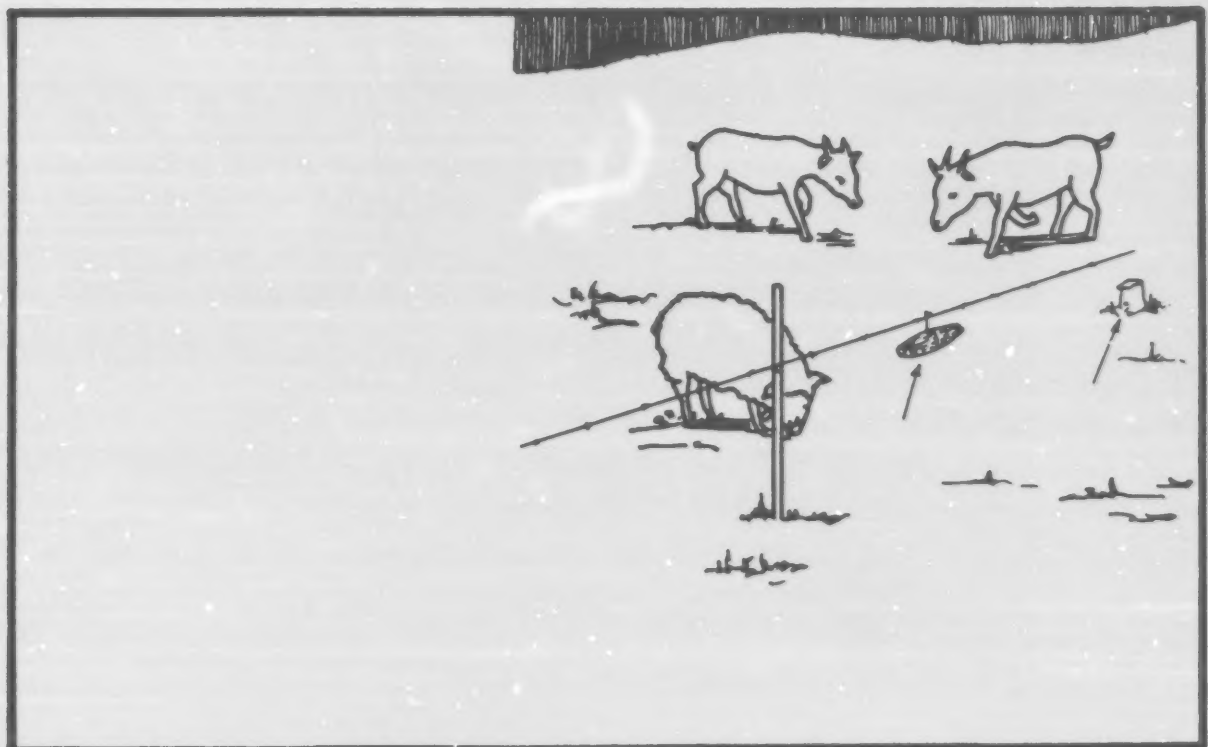
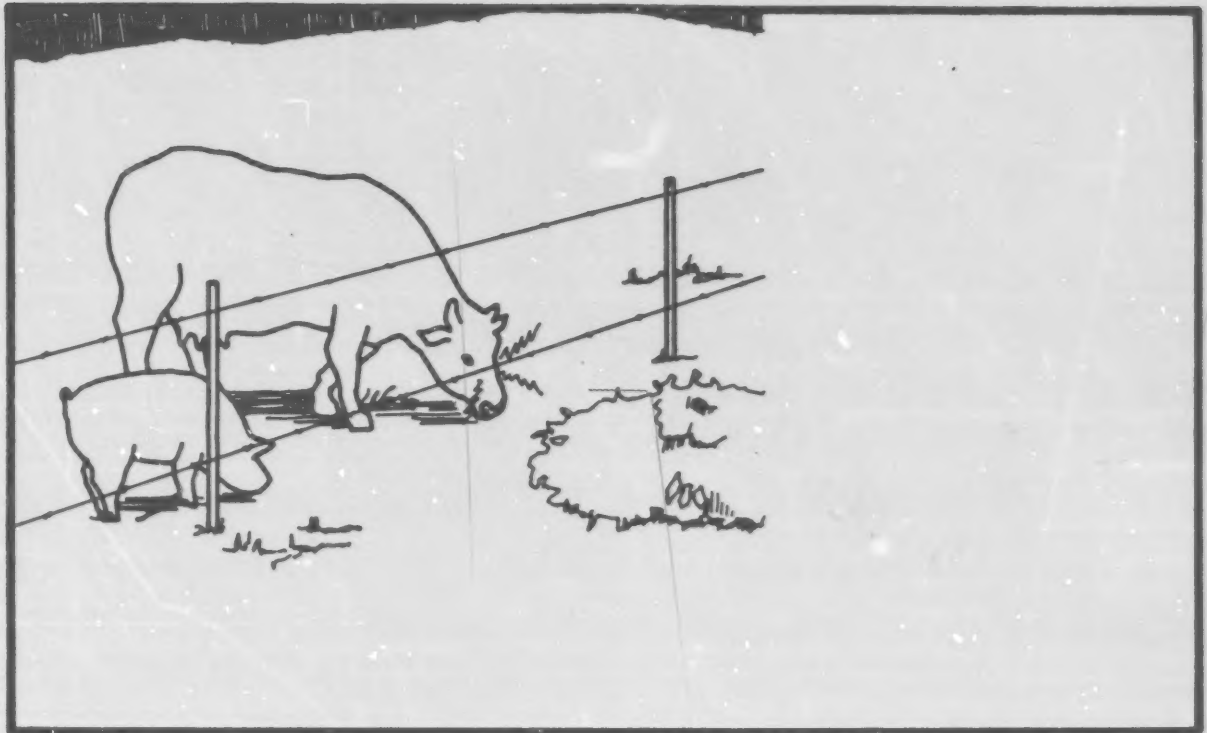
TRANSPARENCY VII-2-B

MESH WIRE TYPE OF FENCING



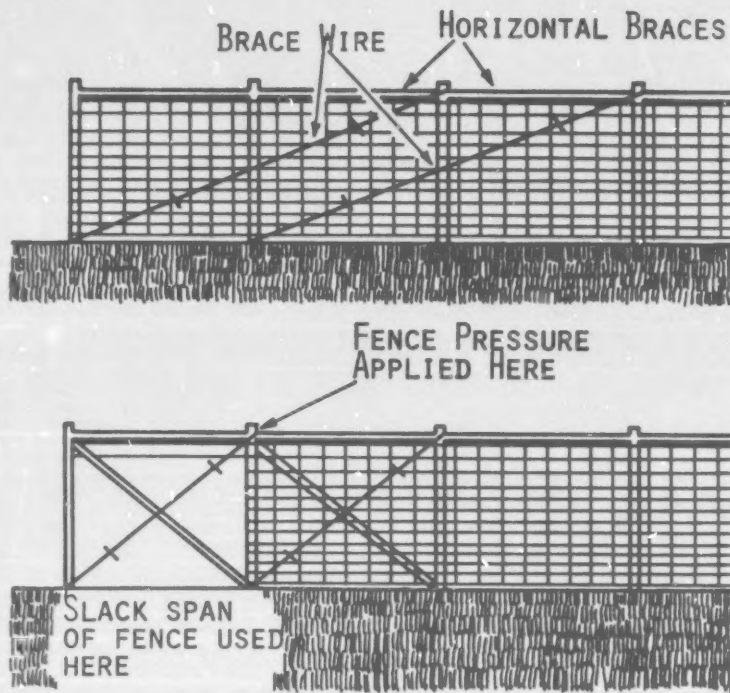
TRANSPARENCY VII-2-C

ELECTRIC FENCING

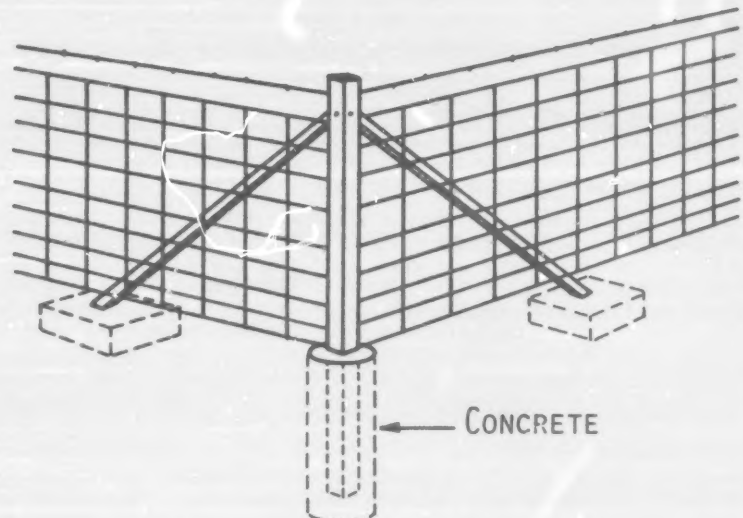


TRANSPARENCY VII-2-D

ROSEMONT

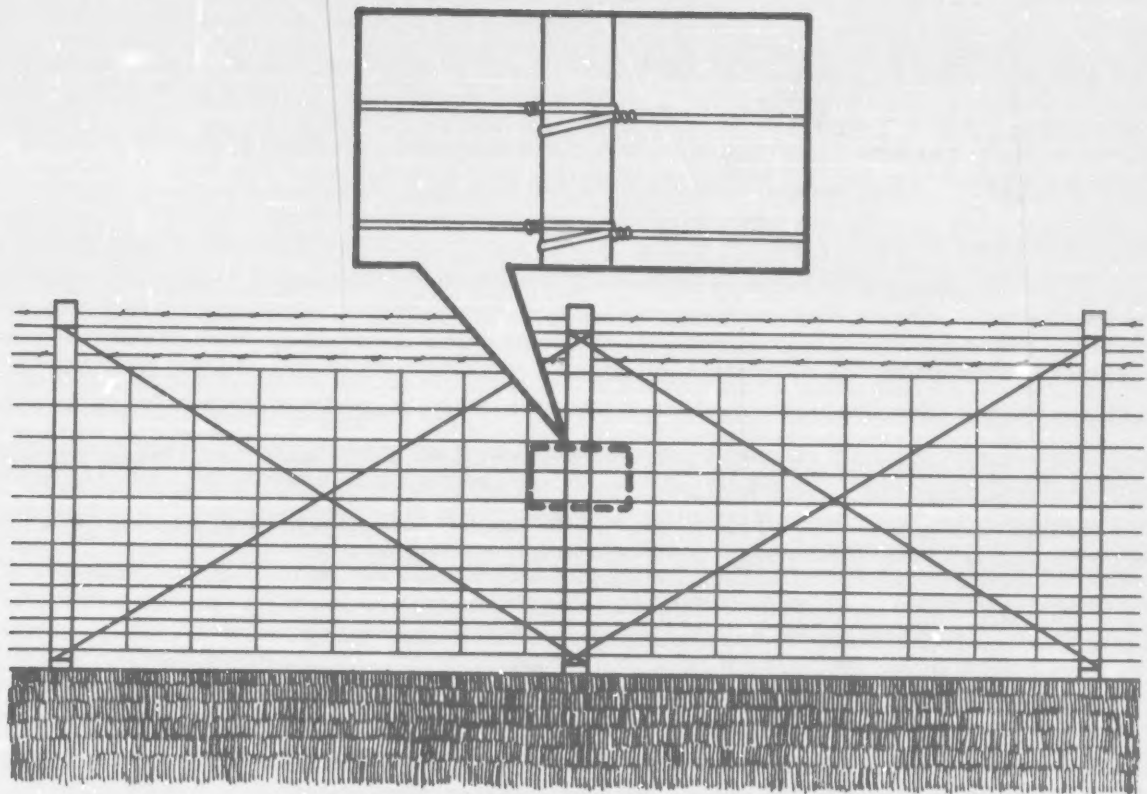


STEEL DIAGONAL-BRACE ENDS



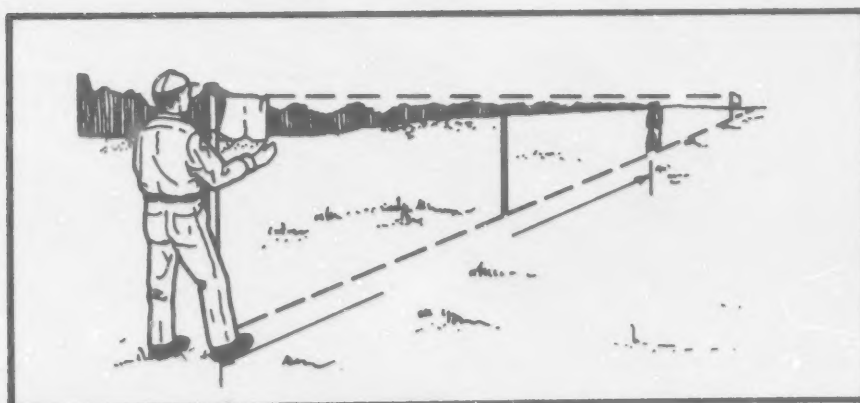
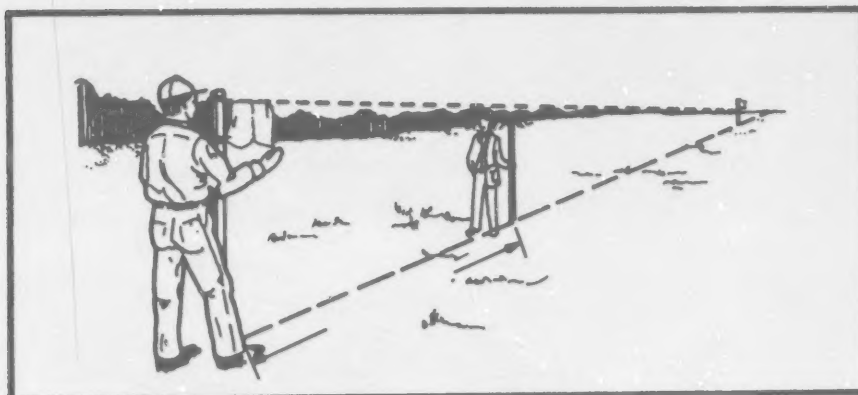
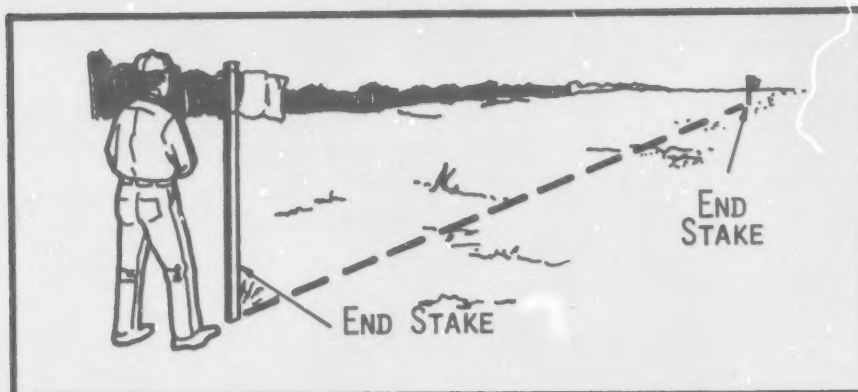
TRANSPARENCY VII-2-E

BRACED - LINE - POST ASSEMBLY



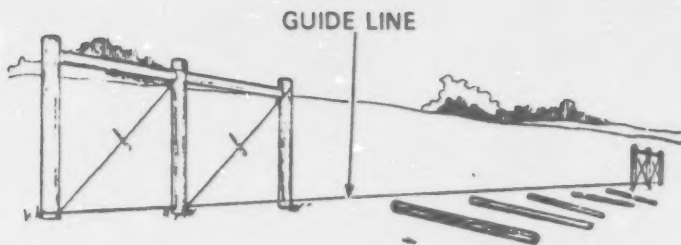
TRANSPARENCY VII-2-F

LAYOUT OF FENCE LINE



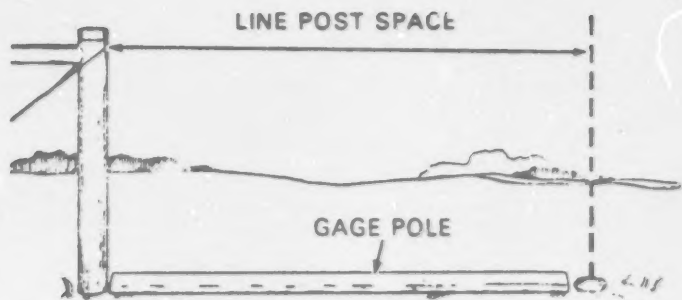
TRANSPARENCY VII-2-G

INSTALLING WOOD LINE POSTS



STRETCH CORD OR BARBED WIRE BETWEEN ANCHOR POST ASSEMBLIES FOR A GUIDELINE.

MEASURE LINE POST SPACINGS WITH A GAGE POLE.



MARK GROUND LINE ON POST OR DIGGING TOOL WITH CHALK OR CRAYON.

TRANSPARENCY VII-2-H

FENCING FASTENERS



U-SHAPED STAPLE



L-SHAPED STAPLE



WIRE CLIP



PLAIN SHANK



FLUTED SHANK



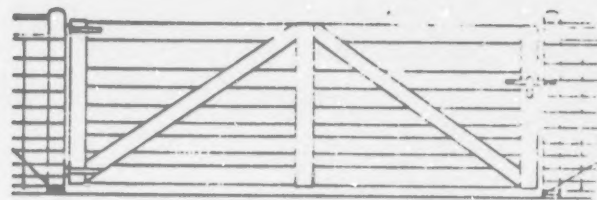
SCREW SHANK



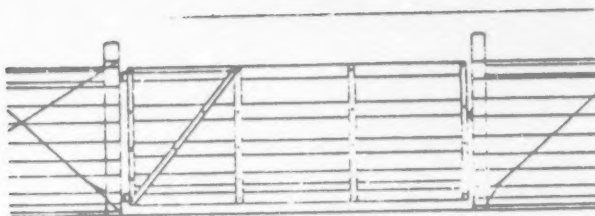
ANNULARLY THREADED

TRANSPARENCY VII-2-1

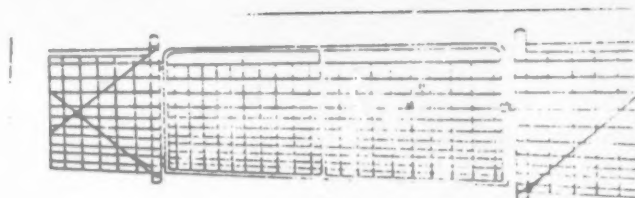
TYPES OF GATES



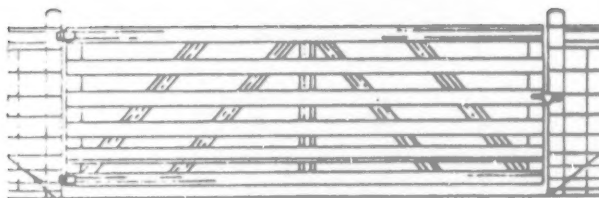
DOUBLE BRACE



WOOD GATE-STEEL BRACING

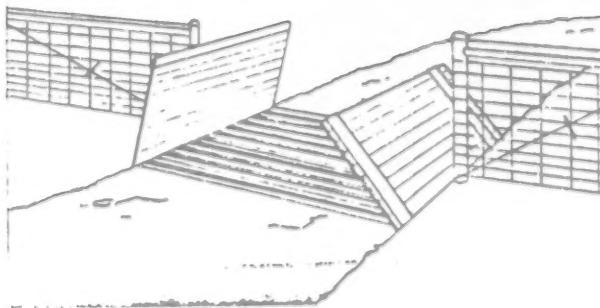
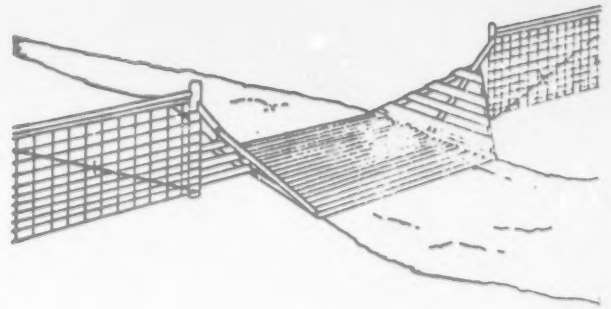
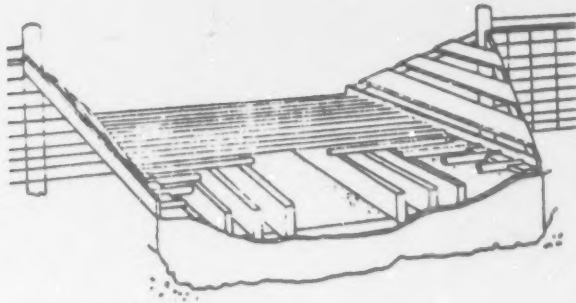


WIRE-STEEL FRAME



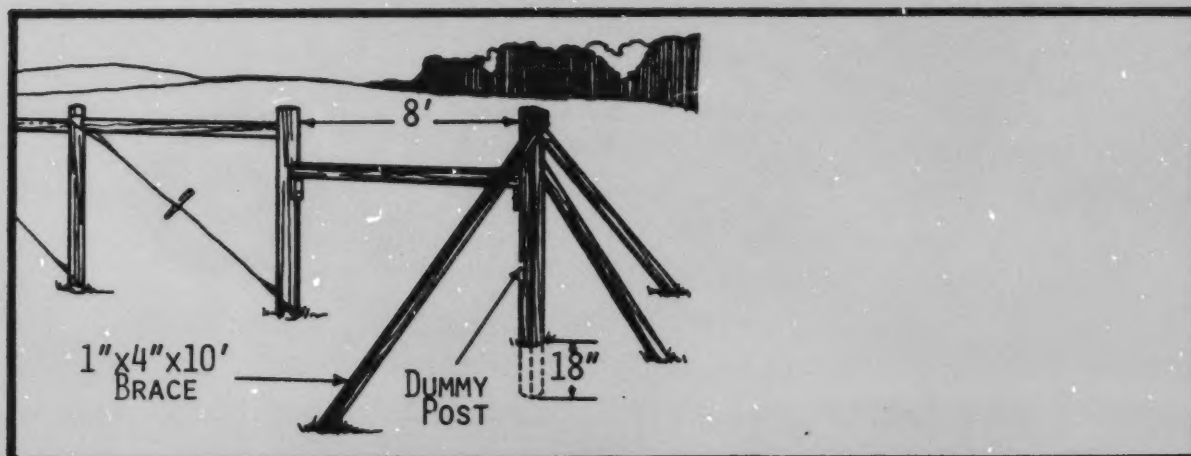
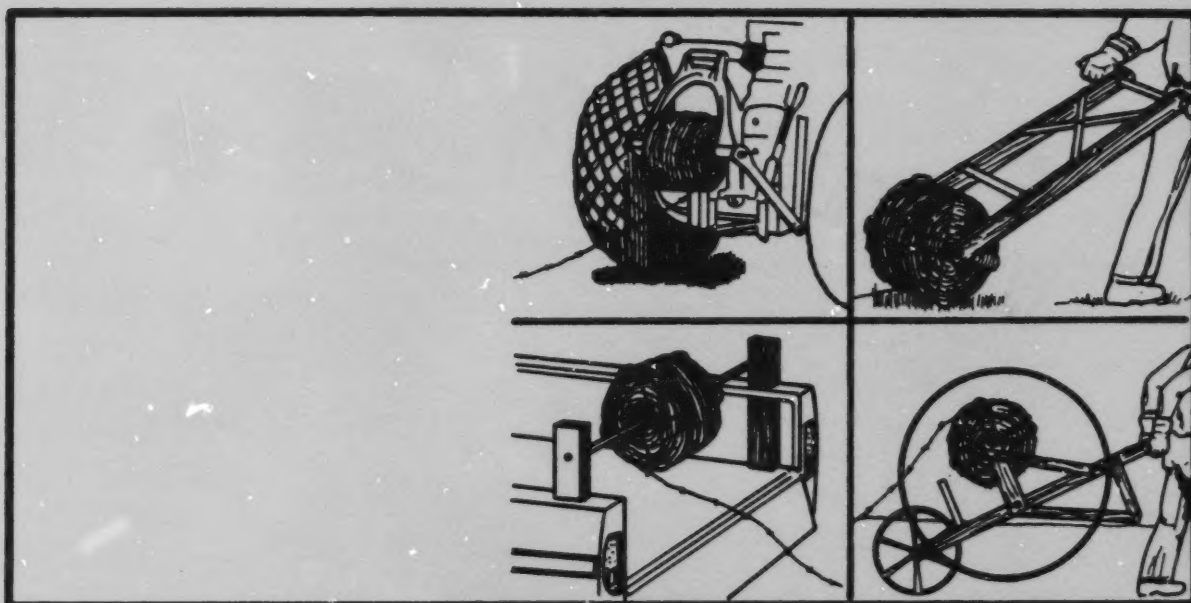
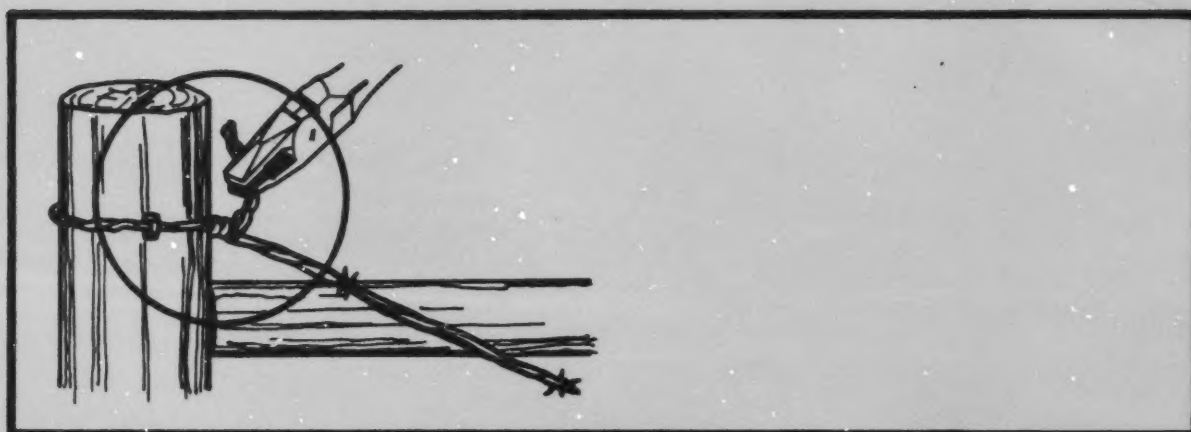
ALUMINUM OR STEEL

TYPES OF CATTLE GUARDS

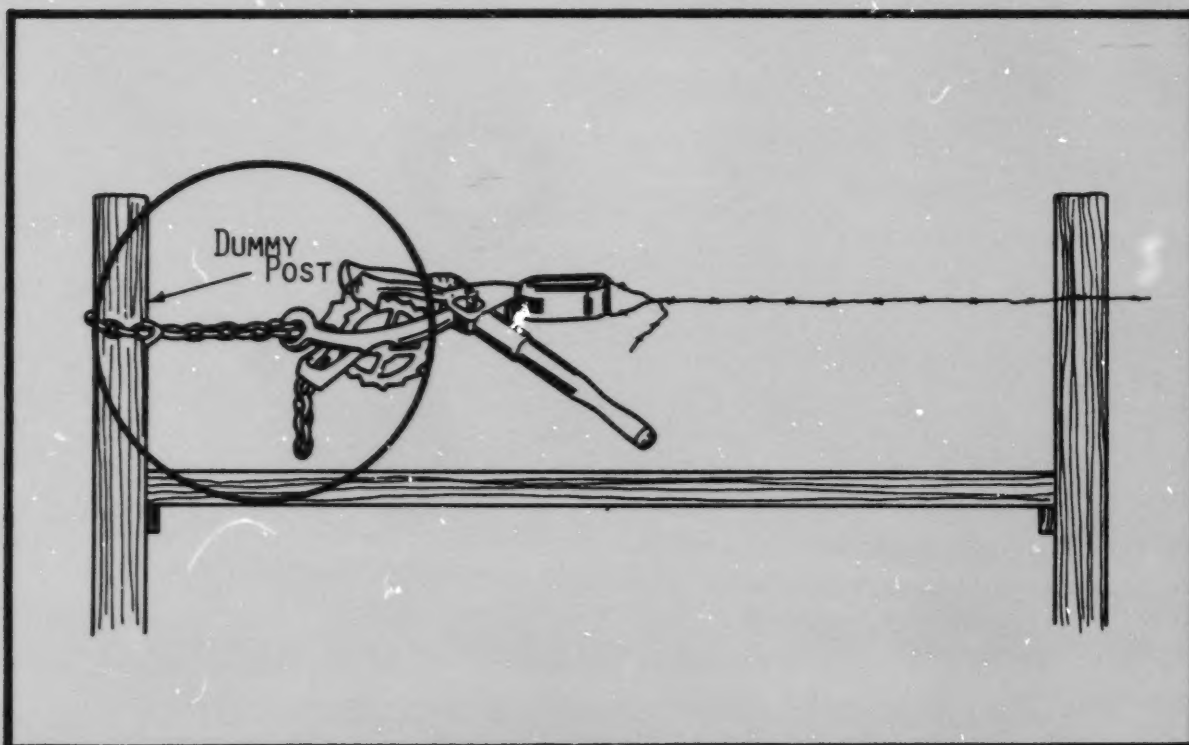
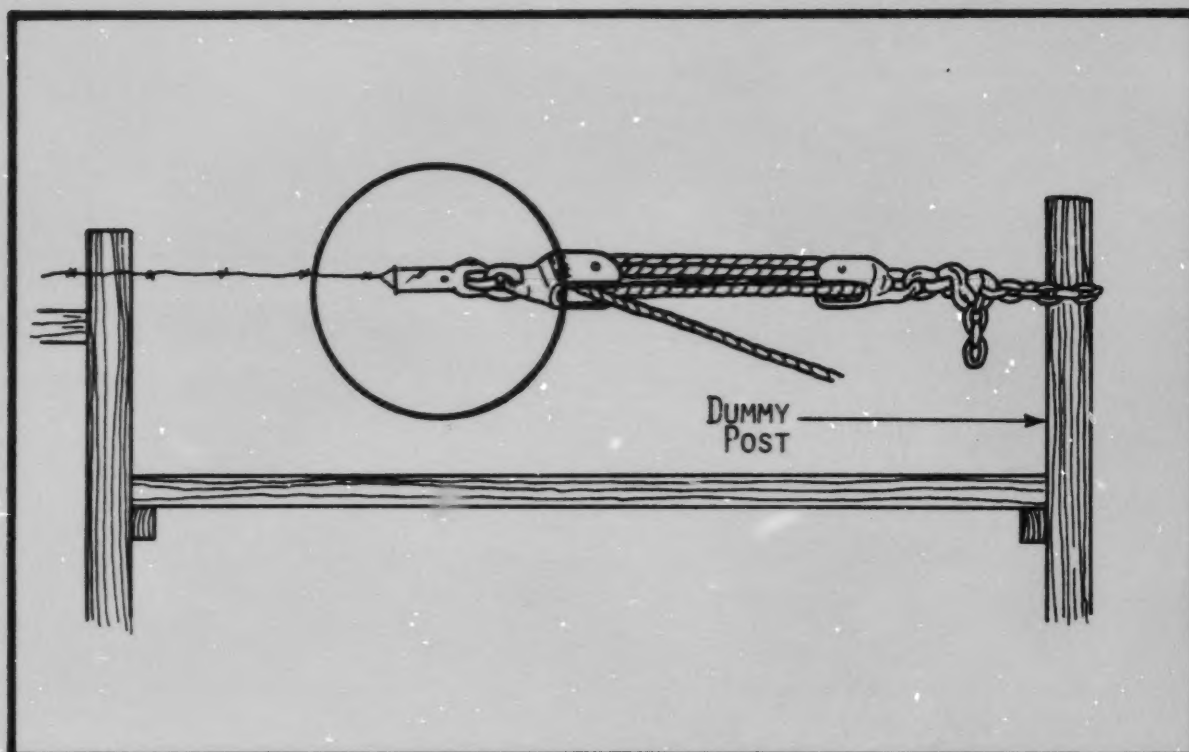


TRANSPARENCY VII-2-K

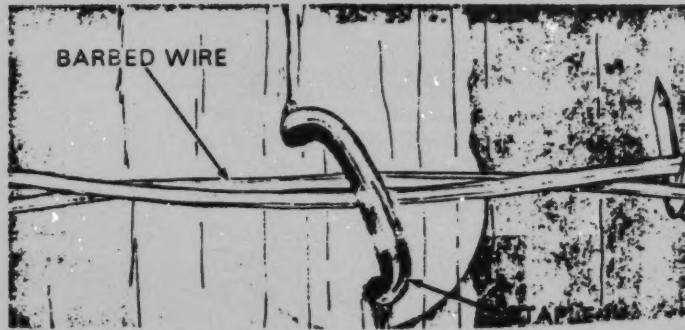
CONSTRUCTING BARBED WIRE FENCING



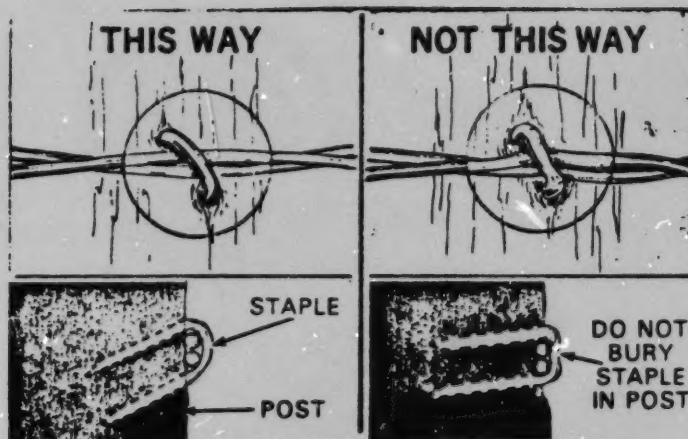
USE OF WIRE STRETCHERS



ATTACHING BARBED WIRE TO POSTS

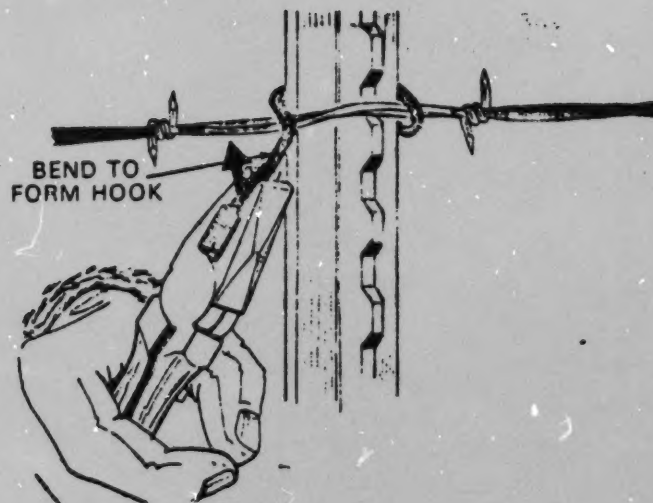
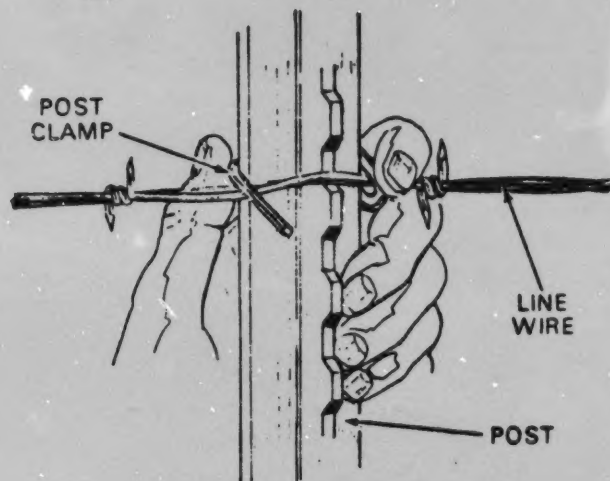


SET STAPLE CROSS-WISE OF GRAIN



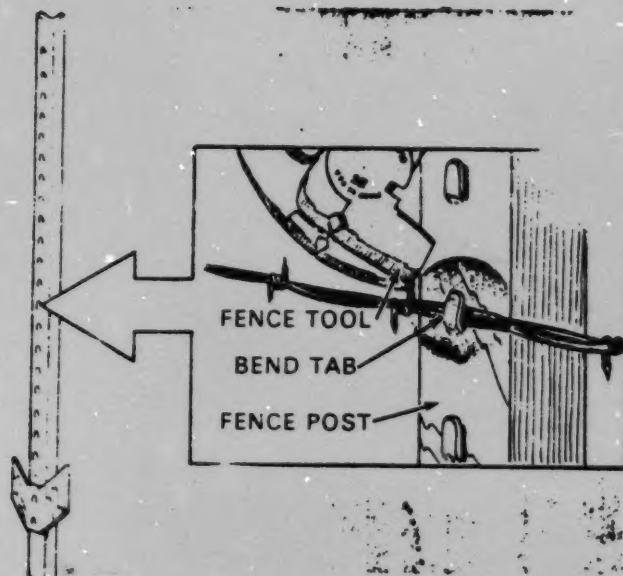
TRANSPARENCY VII-2-N

ATTACHING WIRE TO STEEL POSTS



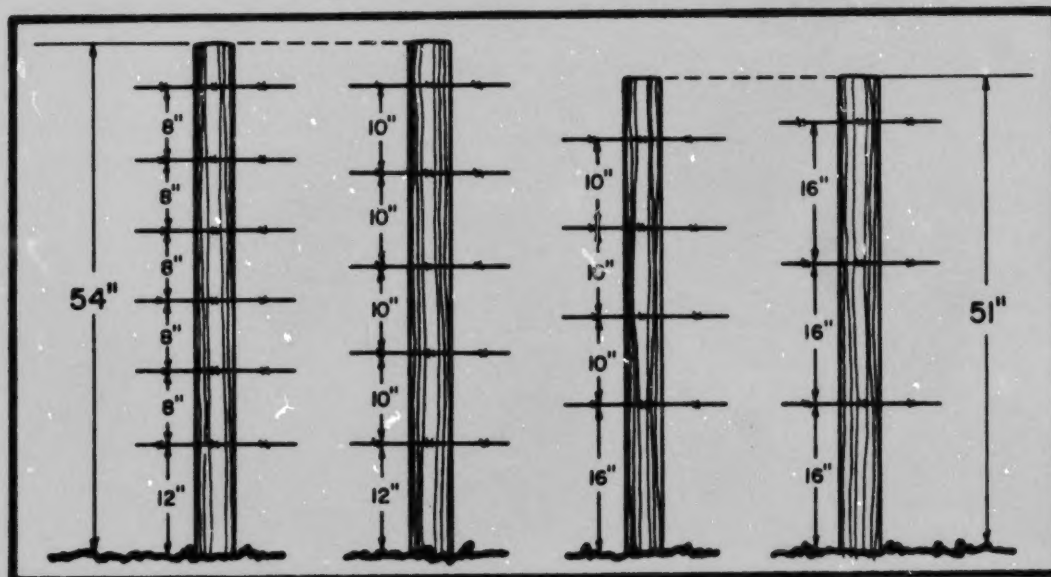
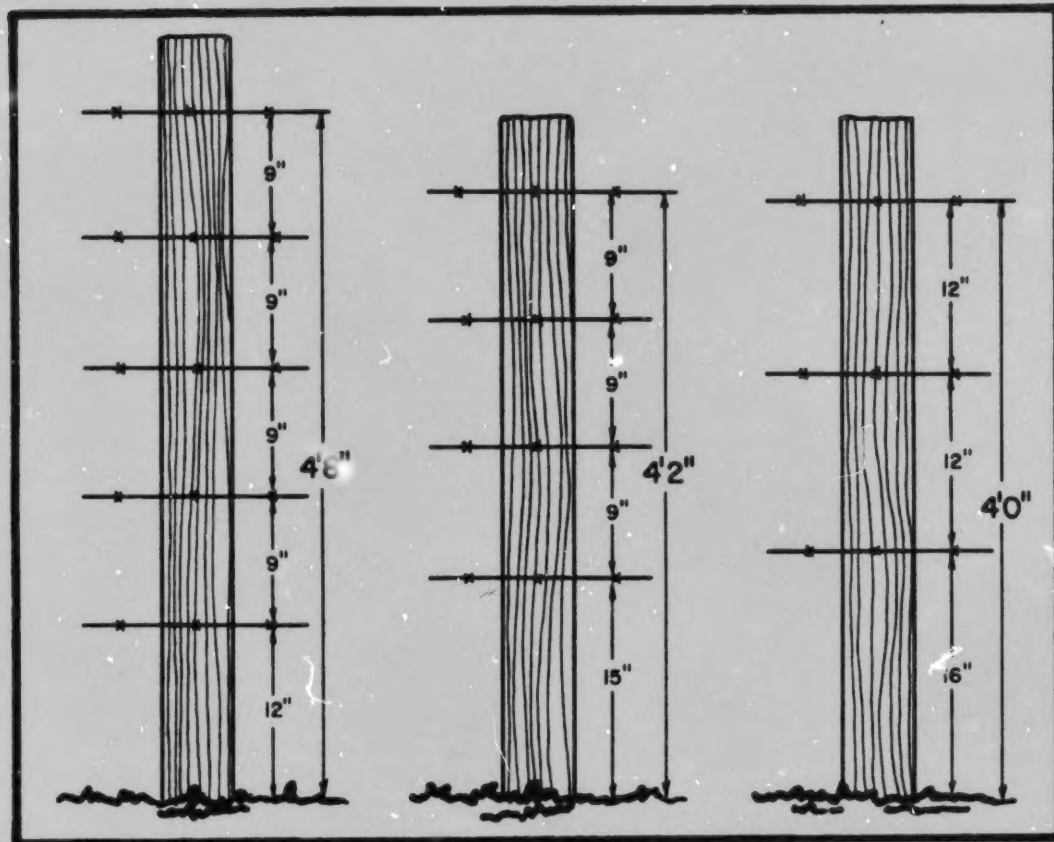
TRANSPARENCY VII-2-0

ATTACHING WIRE TO STEEL POSTS WITH LUGS OR TABS



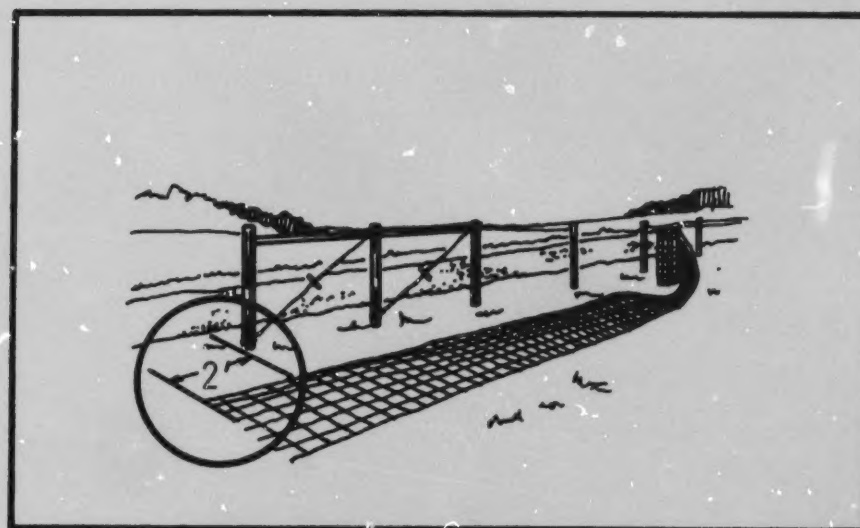
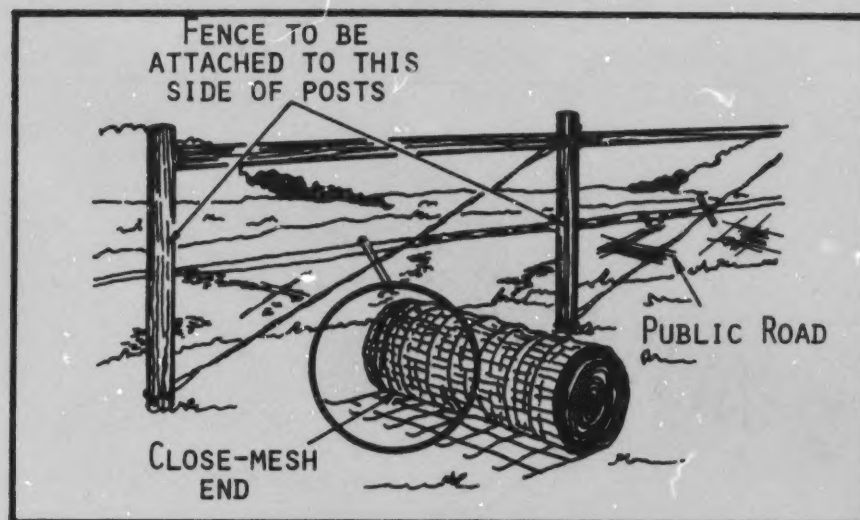
TRANSPARENCY VII-2-P

WIRE SPACING FOR BARBED WIRE FENCING



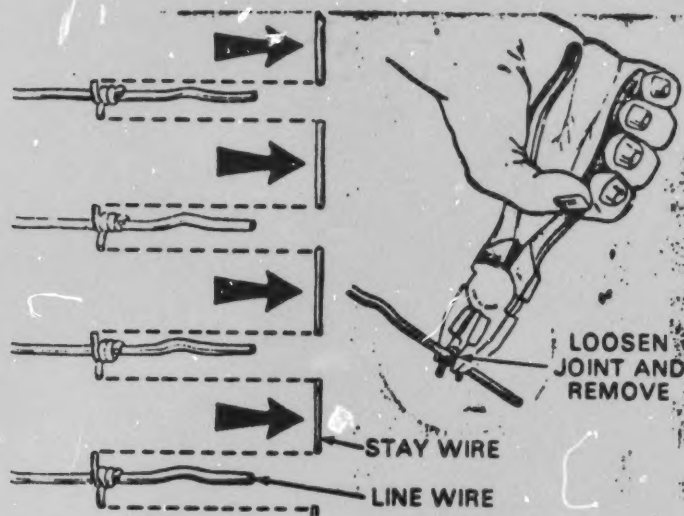
TRANSPARENCY VII-2-Q

LAYOUT FOR WOVEN WIRE FENCING



TRANSPARENCY VII-2-R

ATTACHING WOVEN WIRE TO POSTS

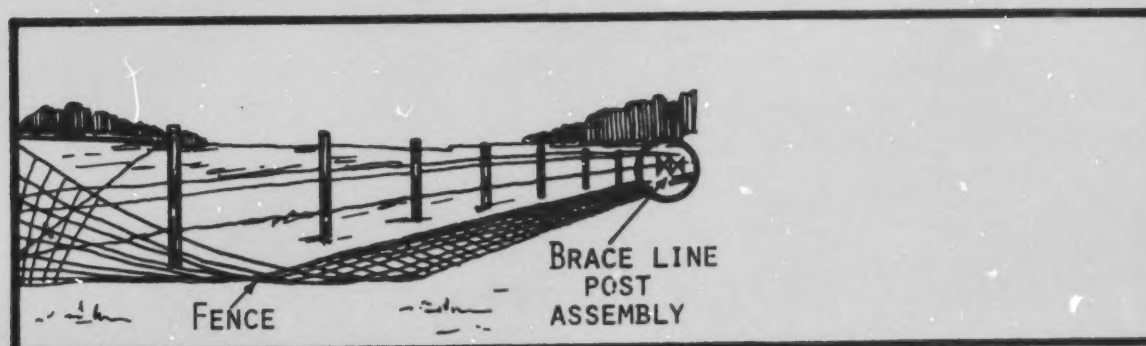
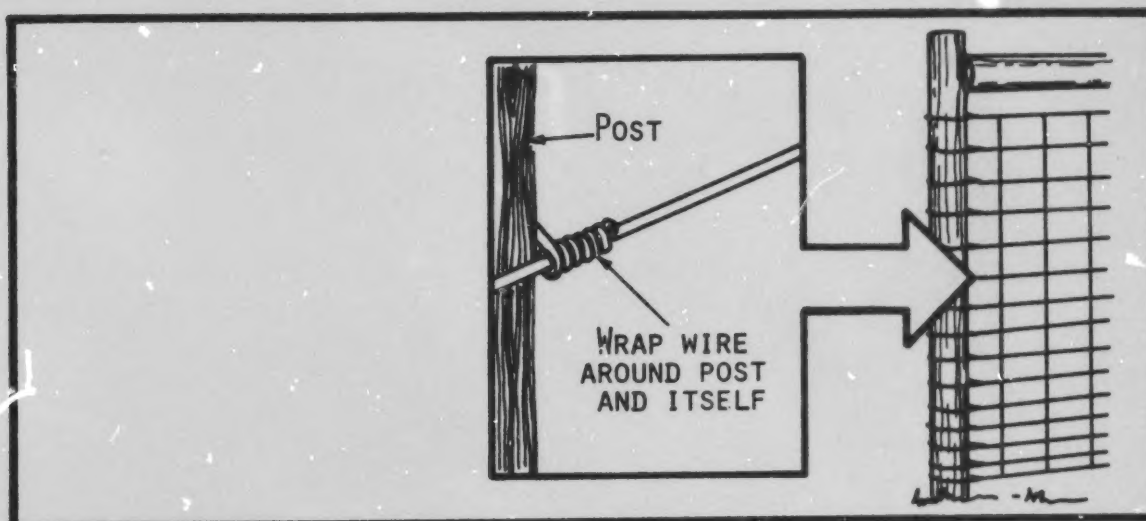
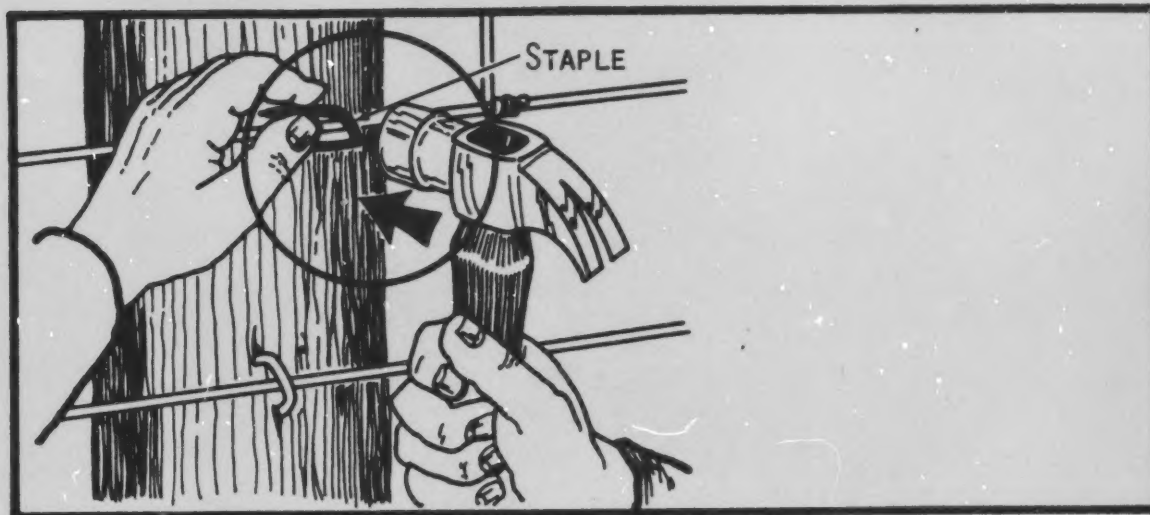


REMOVE ONE STAY WIRE FROM TOP TO BOTTOM

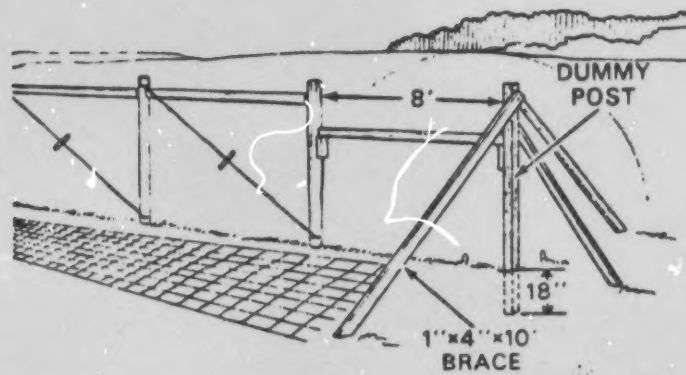


TRANSPARENCY VII-2-S

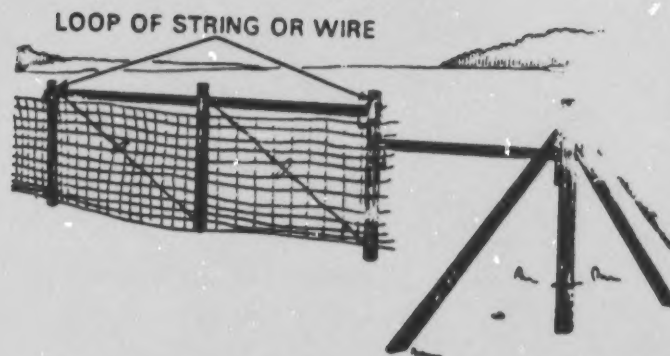
ATTACHMENT OF WOVEN WIRE TO END POST



STRETCHING WOVEN WIRE



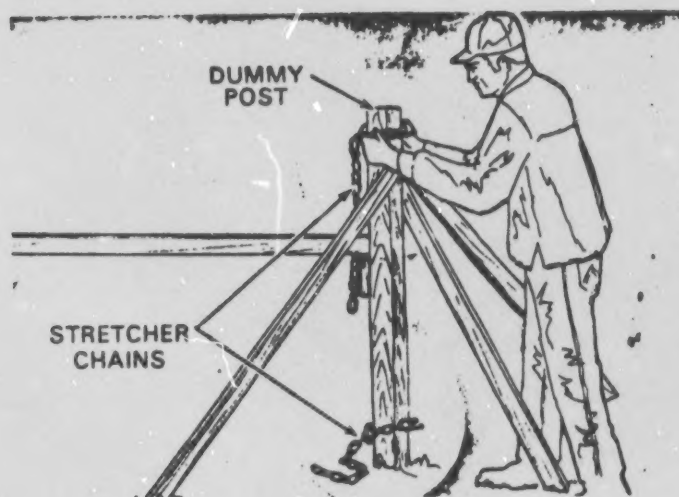
ERECT DUMMY POST FOR ATTACHING STRETCHERS



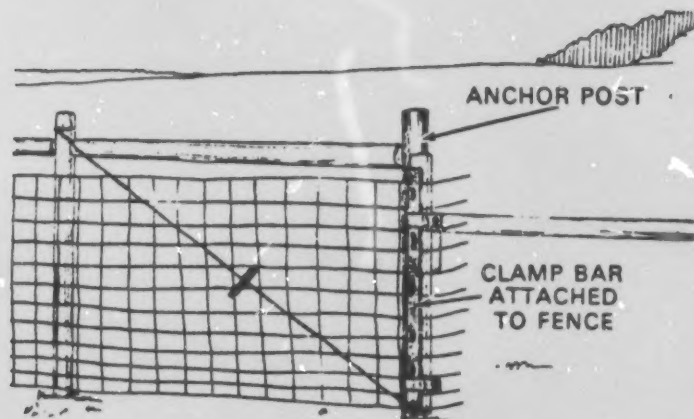
STAND FENCE AGAINST LINE POSTS

TRANSPARENCY VII-2-U

STRETCHING WOVEN WIRE



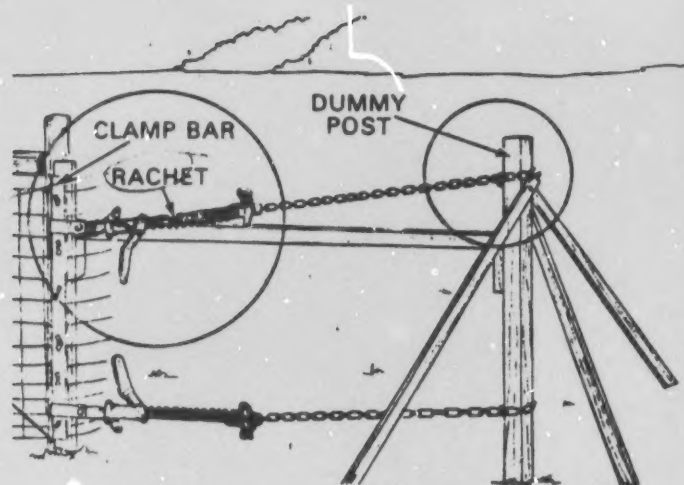
ATTACH CHAIN OF STRETCHERS TO DUMMY POST.



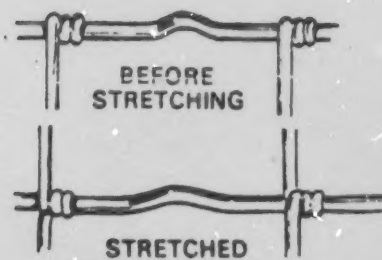
ATTACH CLAMP BAR TO FENCE.

TRANSPARENCY VII-2-V

STRETCHING WOVEN WIRE



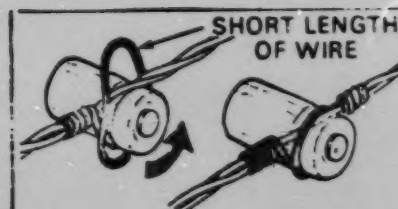
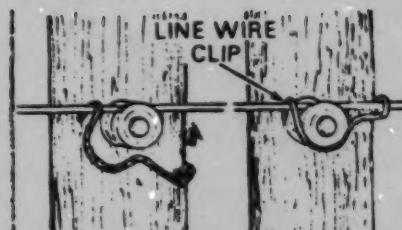
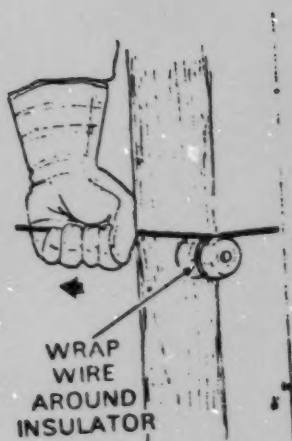
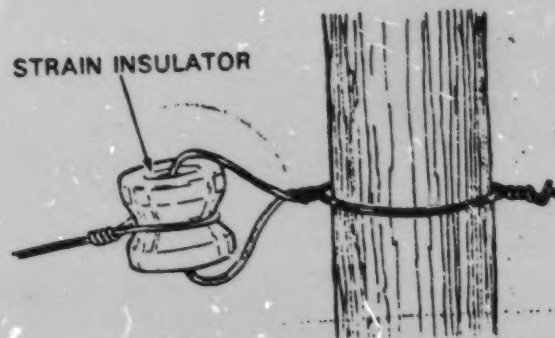
ATTACH RATCHETS TO CLAMP BAR.



STRETCH UNTIL ONE-THIRD OF THE
TENSION IN THE CURVE IS REMOVED.

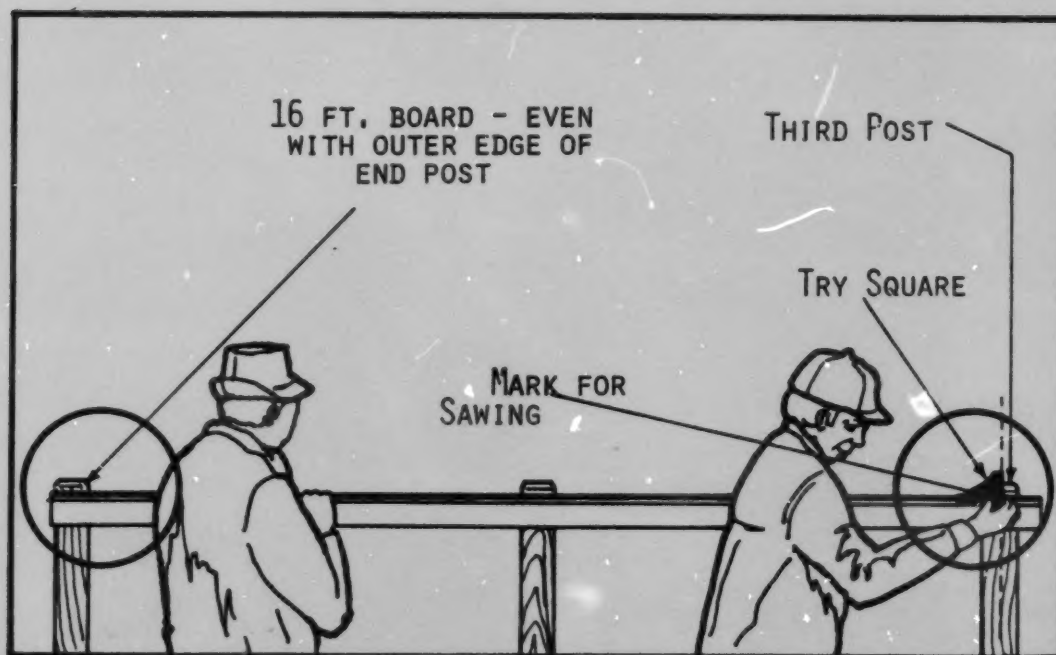
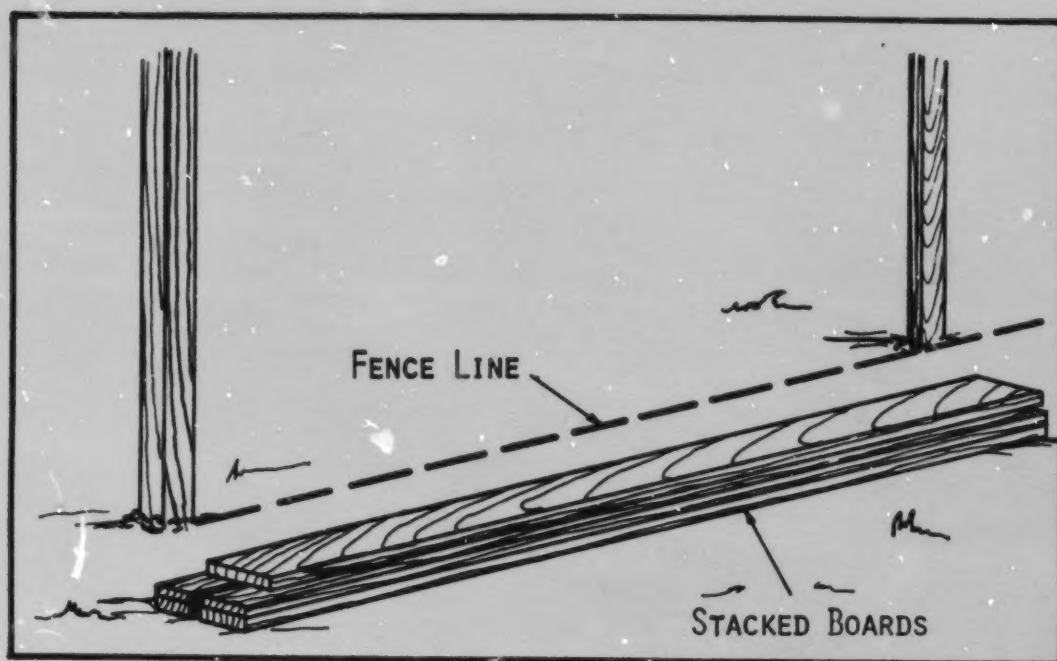
TRANSPARENCY VII-2-W

ATTACHING WIRE TO INSULATORS

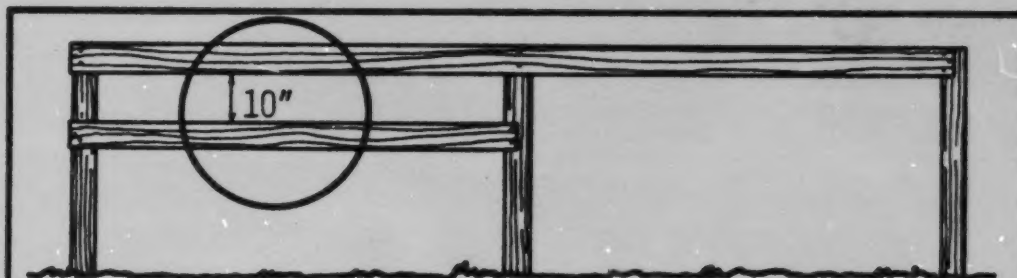
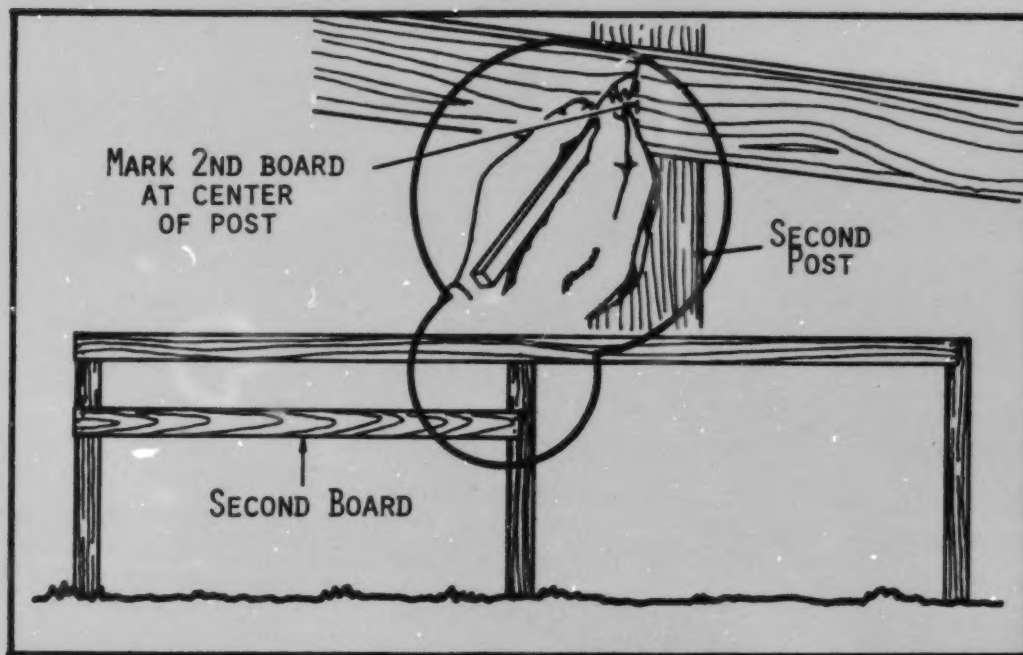


TRANSPARENCY VII-2-X

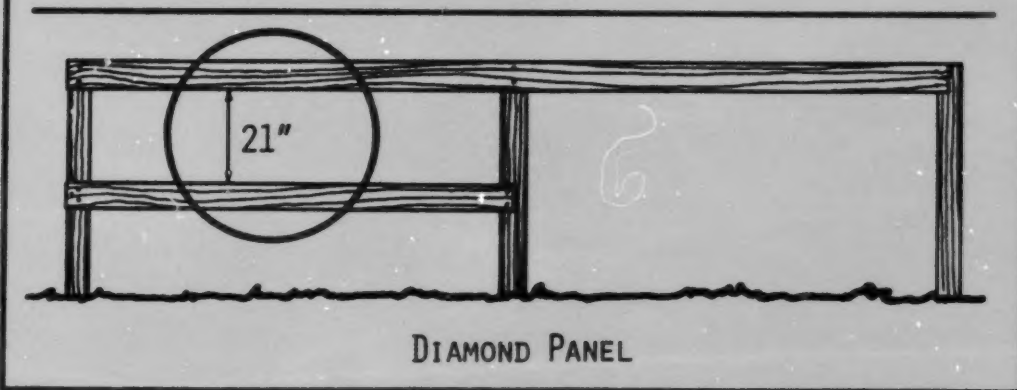
LAYOUT AND MARKING OF BOARD FENCING



PLACEMENT OF BOARD FENCING



STRAIGHT PANEL



DIAMOND PANEL

TRANSPARENCY VII-2-Z

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 3: Farm Painting

I. Preparation for Instruction

A. Objectives

1. Terminal: Demonstrate proper painting procedures.
2. Specific:
 - a. Discuss the importance of painting unprotected surfaces.
 - b. Describe the different types of paints.
 - c. Determine the amount of paint needed.
 - d. Explain the brush painting process.
 - e. Name the items of equipment needed for spray gun painting.
 - f. Identify the parts of a spray gun.
 - g. Discuss two types of spray guns.
 - h. Explain how to select spray guns.
 - i. Demonstrate uses of the spray gun.
 - j. Describe the process of cleaning a spray gun.

B. Review of Teaching Material

1. Wakeman, T. J., and V. L. McCoy. The Farm Shop. New York: MacMillan, 1960.
2. Vocational Agriculture Curriculum. Vocational Instructional Services Center, College Station, Texas: Texas A and M University, 1978.

C. Special Arrangements

1. Arrange for several tractors or equipment items to paint as class exercises.
2. Secure appointment with local equipment dealer or automotive body repair shop to observe the spray painting process.

D. Materials required

1. Paint brushes
2. Spray paint equipment
3. Paint

II. Presentation of Lesson

A. Motivation

Discuss the need for protection of farm building and equipment by painting.

B. Content Outline

1. Importance of painting unprotected surfaces:
 - a. Protection from decay, corrosion, and wear
 - b. Maintain value of equipment and property
 - c. Reduce maintenance and repair costs
 - d. Improve the appearance of buildings and equipment
2. Types of paint:
 - a. Enamel -- This is used mainly for inside woodwork.
 - b. Rubber-base -- Paints of this type mix with water and have replaced many oil-based paints.
 - c. Outside paint -- This paint is generally an oil-base paint which includes different types of pigments and oxides to provide different types of protection such as mildew resistance and rust inhibition.
 - d. Aluminum -- This type paint is needed on metal following application of red or blue lead paint. It prevents bleed-through.
 - e. Cement -- Cement water paints prevent moisture from entering masonry walls.
3. Determine amount of paint needed
 - a. Most quality paints will cover 45 square feet of surface area per gallon. This varies, depending on how thick it is applied and the condition of the material being painted.
 - b. Calculate total square feet of building or structure to be painted. This is done by multiplying height by width of surface. Total up all calculations for all surfaces and divide by the recommended coverage listed on the paint label. This number will give the number of gallons of paint required.
4. Steps to painting
 - a. Prepare the surface
 - 1) New surfaces -- Smooth the surface and wipe clean of all dirt, grease, etc. Apply a good primer on both metal and wood surfaces.

- 2) Old surfaces -- Remove as much old paint as possible by scraping or sanding. Make all repairs on machinery before painting. On wood surfaces, wash clean after scraping using a soap and bleach solution to kill any mildew present.

b. Brush painting

- 1) Hold paint brush with the thumb placed over the small part of the brush handle and fingers on the large part of the brush.
- 2) Dip about one-third of the length of bristles into the paint.
- 3) Remove excess paint from the brush by wiping one side against paint bucket.
- 4) Apply paint in long sweeping strokes in the same direction to form a thin uniform film over the surface.

5. Equipment needed for spray painting

- a. Spray gun -- Suction or pressure type
- b. Air compressor
- c. Paint pressure tank
- d. Air hose of proper strength
- e. Gauge and regulator on air tank to control pressure.

6. Types of Spray Guns

- a. Nonbleeder-type -- With this type, air flow is shut off when the trigger is released. Air and paint are controlled by the trigger.
- b. Bleeder-type -- The air flows constantly through this gun. Paint flows through the tip when the trigger is squeezed.

7. Spray Gun Parts (Transparency VII-3-A)

- a. Air cap -- This controls the spray pattern.
- b. Fluid tip -- This is a nozzle that paint passes through to enter into the stream of air. It is found back of the air cap.

- c. Fluid needle -- This needle is in the fluid tip and permits paint to flow or stops the flow.
- d. Trigger -- This controls the needle action in and out of the fluid tip.
- e. Fluid-needle adjustment screw -- This regulates the amount of paint passing through the fluid tip.
- f. Air valve -- Found on nonbleeder guns, this valve controls the passage of air by trigger movement.
- g. Spreader valve -- This valve controls the air flow to side holes located on the air cap.

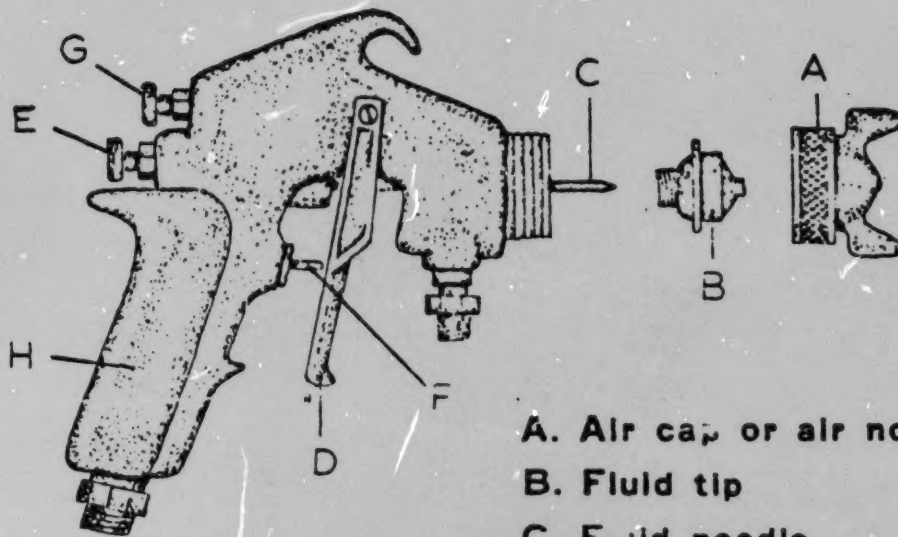
8. Selecting a spray gun

- a. Nonbleeder guns are used with a tank in which air is regulated to a constant pressure. Bleeder guns are used with a continuous-running compressor.
- b. A pressure-type gun will spray paints heavier than light enamels and lacquers, most painting will require 30-50 pounds of pressure.
- c. Internal mix nozzles are used with pressure equipment and slow drying paints.
- d. External mix nozzles are operated either by suction or pressure. They can be used with heavy or light paints.

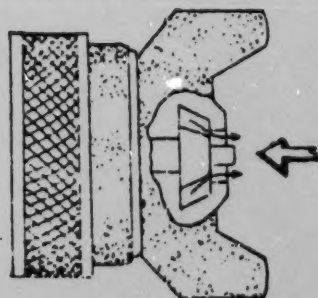
9. Use of Spray Gun

- a. Prepare the surface, making sure that areas not to be painted are covered.
- b. Use a respirator or mask to prevent sickness or injury from excessive fumes.
- c. Mix paint
 - 1) Adding a thinner to paint prevents running, but also reduces the thickness of the paint film on the surface of the object. This means application of additional coats is essential.
 - 2) Strain paint through an old pair of pantyhose or commercial strainer before spraying.
- d. Adjust gun
 - 1) Open spreader adjustment valve.

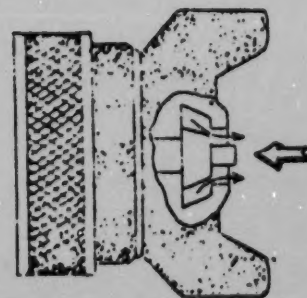
PARTS OF A SPRAY GUN



- A. Air cap or air nozzle
- B. Fluid tip
- C. Fluid needle
- D. Trigger
- E. Fluid adjust screw
- F. Air valve
- G. Spreader adjustment valve
- H. Gun body

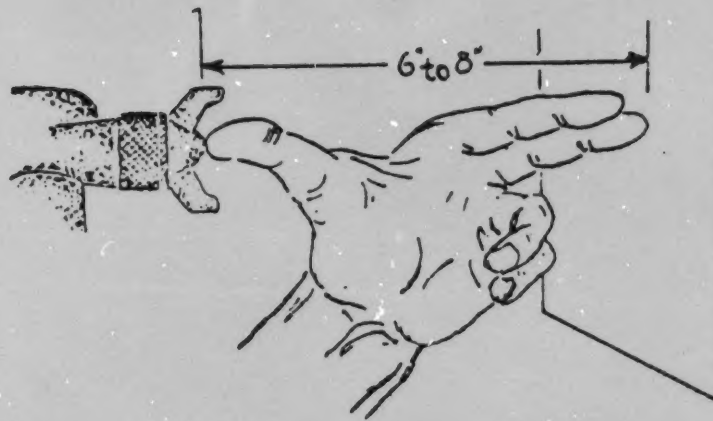


suction nozzle

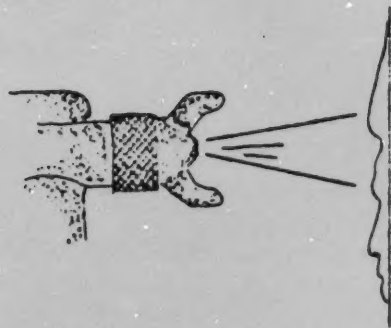


pressure nozzle

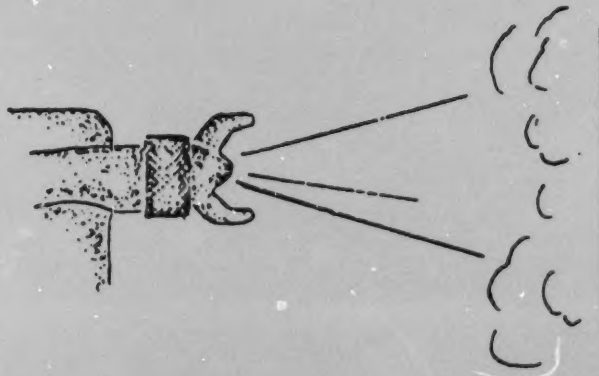
SPRAY GUN POSITION



correct distance from surface



too close to surface



too far from surface

USE OF SPRAY GUN

overlap ends

overlap strokes

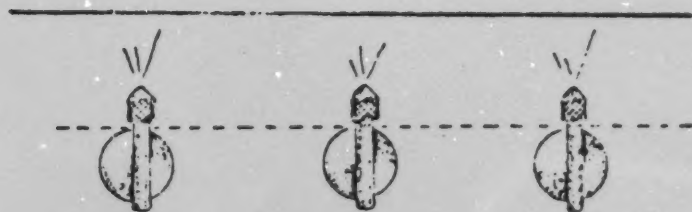


Overlap each parallel stroke

Overlap end of stroke



excessive overspray created by arcing



move gun in straight line

TRANSPARENCY VII-3-C

- 2) Open fluid needle screw -- one thread showing.
 - 3) Check for air leaks and connect hose to cup.
 - 4) Remove atomizing nozzle and press trigger until paint comes out.
 - 5) Replace the nozzle and set the pressure.
 - e. Proper distance is six to eight inches from the surface. Approximate the distance by placing your thumb on the nozzle and stretching fingers to the surface. (Transparency VII-3-B)
 - f. Hold gun parallel to surface and in a vertical position. Overlap should be about 50 percent of each previous lap on the surface. Pull the trigger just after stroke begins and release just before it ends. (Transparency VII-3-C)
10. Proper cleaning of spray gun:
- a. Use good solvent or paint thinner.
 - b. Clean cup with solvent, fill, and blow through the gun with compressed air.
 - c. Clean nozzle parts in solvent.
 - d. Wipe clean and remove excess solvent.

C. Suggested Student Activities

1. For brush painting, secure permission from community people for students to paint sheds, small barns, pump houses, etc.
2. Acquire small machinery items from farmers or other people in the community for students to paint using a spray gun.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 4: Farm Water Supply

I. Preparation for Instruction

A. Objectives

1. Terminal: Identify and describe planning and implementation procedures necessary for water supply and sewage disposal on the farmstead.
2. Specific:
 - a. Discuss the importance of a clean water supply.
 - b. Identify the components of a water supply system.
 - c. Identify the sources of water for the farmstead.
 - d. Determine the need for water conditioning.
 - e. Determine the required pump capacity.
 - f. List the types of water pumps available.
 - g. Determine the type of pump to use.
 - h. Discuss types of water storage systems on the farmstead.
 - i. Discuss the importance of septic tanks.
 - j. Describe the operation and construction of a septic tank.
 - k. Describe the proper size and placement of septic tanks.
 - l. Discuss the three purification methods for sewage discharge.

B. Review of Teaching Material

Planning for an Individual Water System. Athens, Ga.:
American Association for Vocational Instructional
Materials, 1973.

C. Special Arrangements

Contact the local dealer handling well pumps. Arrange a date for him to bring some pumps to the class and show how each type operates.

D. Materials Required

1. Poster board
2. Colored pencils or pens

II. Presentation of Lesson

A. Motivation

Discuss the necessity of pure water that is readily available to the farmstead. Illustrate the various ways water is important to vegetable gardens, crops, livestock, and humans.

B. Content Outline

1. Importance of water supply:
 - a. Sanitation in the farm dwelling,
 - b. Saves labor and time,
 - c. Increases production for all livestock,
 - d. Increases vegetable production, and
 - e. Fulfills human needs.
2. Components of the water supply system:
 - a. Water source,
 - b. Water pump,
 - c. Water storage tank,
 - d. Distribution pipe, and
 - e. Water-treatment equipment.
3. Water Sources
 - a. Drilled well -- This type of well is usually 4-8 inches in diameter and has been encased with a steel casing to prevent soil from caving in and filling the hole. The water supply is usually adequate. (Transparency VII-4-A)
 - b. Driven well -- A driven well is used when the water-table level is in a water-bearing sand or gravel 25-100 feet below the surface. A 1½-2 inch pipe is driven into the ground until it is below the the water level. The amount of water for any one well of this type is limited. (Transparency VII-4-B)
 - c. Dug well -- This type well is usually 3-20 feet in diameter and less than 50 feet deep. It is deep enough to get below the water level. The sides are cased with tile, stone, or brick. (Transparency VII-4-C)
 - d. Bored well -- This well is made with an earth auger. It is usually 8-14 inches in diameter and less than 100 feet deep. Casing is also used in the well. (Transparency VII-4-D)
 - e. Cistern -- This is simply a watertight, underground reservoir used to store runoff water from buildings. (Transparency VII-4-E)
4. Determine the need for water conditioning -- Water supplies may contain minerals, acids, or foreign matter that makes the water unsatisfactory for one's needs.

- a. Hardness -- This is probably due to the presence of calcium and magnesium. Aluminum and iron also contribute to hardness. This can be controlled by installing a water softener that operates on a reverse osmosis process and has an activated-carbon filter that removes large particles first. Servicing is required every one to three years.
- b. Red water -- Red water is a symptom of too much iron in the water. It creates hard-to-remove stains on plumbing fixtures. It can be controlled by using phosphate feeders, ion-exchange units, an oxidizing filter, or chlorinator and filter units. These are installed in the water supply line before the water gets to the storage tank to prevent the slime and discoloration from getting into the system.
- c. Brownish-black water -- This is indicative of manganese in the water. If manganese particles are present, they can frequently clog lines. Control for this problem is the same as that for controlling iron in the water.
- d. Acidity -- Acid water tends to be corrosive to metal parts. In addition, if acid is present, it will prevent complete removal of iron. Acidity can be corrected by installing a soda-ash feeder or a neutralizing tank. The soda-ash solution must be replenished every two to three weeks. The neutralizing tank uses limestone and should be checked annually.
- e. Off flavor -- There may be a rotten-egg odor or taste to water as well as the taste of chlorine or iron. It is not usually hazardous but can be undesirable for drinking or cooking. This most common connection procedure is installation of a carbon-bed filter in the water supply line.

5. Pump Selection:

- a. Determine capacity of pump
 - 1) Household uses (Transparency VII-4-F)
 - a) List all home uses and peak demand allowance for each in gallons per minute, and
 - b) Total demand for all household uses.

- 2) Irrigation, cleaning, etc. (Transparency VII-4-G)
 - a) List all lawn, garden, and miscellaneous uses and the water demand for each,
 - b) Determine which uses are competing for water at the same time, and
 - c) Determine demand allowance for the pumps.
- 3) Watering livestock and poultry (Transparency VII-4-H)
 - a) List all of the watering units one has in use and the demand for each, and
 - b) Determine demand allowance for the pump for livestock and poultry watering.
- 4) For all combinations
 - a) Determine which use requires the greatest fixture flow for all three types of water demands.
 - b) Substitute fixture flow figure of a particular appliance or piece of equipment for its demand-allowance figure if it is larger.
 - c) Determine pump capacity needed by adding all demand allowances and fixture flow figures. This capacity should be in gallons per minute (gpm). Pump selection would be based, then, on how many gallons per minute it can pump. (Transparency VII-4-I)
6. Types of Pumps: (Transparencies VII-4-J and VII-4-K)
 - a. Piston pump,
 - b. Centrifugal pump,
 - c. Centrifugal-jet pump, and
 - d. Turbine pump.
7. Factors in Selecting the Type of Pump to Use
 - a. Depth of water

- 1) If the water level never gets lower than 15 to 25 feet below the pump, use a shallow-well pump.
- 2) If the water level is more than 25 feet below the pump, selection is made from a variety of pumps.

b. Well Size

- 1) This is a problem most pronounced in deep-well installations. Wells less than 4 inches in diameter may create problems if large amounts of water are needed. However, a deep-well piston pump can be used in a well as small as 2 inches in diameter.
- 2) Jet pumps can also be used in wells as small as 2 inches in diameter.

c. Pressure range needed for adequate service

- 1) Most pumps are designed for 20-40 psi pressure range. The pump cuts on when pressure goes to 20 psi and cuts off when it reaches 40 psi.
- 2) A higher pressure range of 30 to 50 psi or 40 to 60 psi is recommended in many cases where demand is great on one pump. Also, since so many appliances and items of equipment require water on a farm, many recommend a higher pressure.

d. Height water is lifted above pump

- 1) If the highest water outlets are no more than 20 feet above the pump, no extra considerations are necessary for pump selection.
- 2) If a shallow-well pump is more than 20 feet below the highest water outlet, this must be considered. This may require a heavier pump-and-motor combination to get water to all the outlets. The same is true with a deep-well pump.

e. Pump location -- This factor deals with whether or not the pump can be offset from the well or water source; that is, can the pump be set away from the well or must it be placed in the well?

- 1) Shallow-well pump can be offset if...

- a) Pipe size is ample between the water source and pump, and
 - b) Total height between water source and pump is within suction limits of the pump.
- 2) A deep-well jet pump can be offset.
 - 3) A submersible pump must be placed in the well. The storage tank can be offset.
- f. Pump durability and efficiency
- 1) Durability is dependent on proper pump selection and maintenance and on not overloading it causing it to burn out.
 - 2) Overall pump efficiency decreases rapidly at greater depths.
- g. Dealer Service
- 1) Help select a pump that best fits the needs of the farm.
 - 2) Supply emergency parts and service for the pump when needed.

8. Types of Water Storage Tanks:

- a. Elastic pressure cells -- A metal cylinder with a 3-gallon capacity and an elastic liner inside that contracts to force water out when needed. (Transparency VII-4-L)
- b. Pressure tank -- Pressure tanks operate by compressed air forcing water out as needed. Water is put into the tank until the air is compressed to a point of 40 psi and the pump shuts off. When water use is started, the tank is emptied until it reaches 20 psi pressure. The pump then cuts back on to fill the tank. (Transparency VII-4-L)
- c. Gravity tank -- A gravity tank is located well above the level of buildings. Pressure is produced by gravity. The higher the tank, the greater the pressure. (Transparency VII-4-M)
- d. Reservoirs -- These are simply storage areas for water that provide no pressure in and of themselves. A second pump is used to pump water to the demand points from the reservoir. (Transparency VII-4-M)

9. Septic Tank -- In rural settings, septic tanks are essential for sanitation and convenience on the farmstead.
 - a. Septic tanks help the decomposition of components in raw sewage wastes.
 - b. Raw sewage consists of water and settleable solid materials.
 - c. The settleable solids are called organic materials. When they settle to the bottom of the tank they are called sludge.
 - d. The lighter organic materials rise to the surface and are referred to as scum.
 - e. The sewage that is not decomposed by the bacterial activity must be removed manually. This requires periodic cleaning.
 - f. The liquid content (effluent) of the septic tank is percolated into the soil and passes into natural water tables under the surface. Avoid discharging large amounts of water into the septic tank, as this tends to flood the tank and forces solid material into the purification unit.
10. Construction of the septic tank: (Transparency VII-4-N)
 - a. It is usually made of concrete 6 to 8 inches thick and reinforced with steel bars. Septic tanks are longer than they are wide with a minimum width of 2 feet 6 inches and length of no less than 5 feet.
 - b. Inlet and outlet inverts are made of a long-turn sanitary tee that must be cast into the concrete sides of the tank. The invert should extend not more than 15 inches into liquid content of the tank. This allows incoming sewage to be emptied into the tank below the scum line.
 - c. Inverts should be placed at least four feet from the bottom.
 - d. The bottom of the tank should slope to one low point. This helps gather settled materials in one place and simplifies removal.
 - e. A manhole cover must be a part of the tank and extend a few inches above the ground surface. This manhole is necessary for cleaning, inspection, and repair of the septic tank. It should be noted that

after long months of use, harmful and dangerous gases accumulate in the tank. Therefore, the manhole cover should be removed several days prior to cleaning the tank. This will ensure plenty of ventilation while a person is working in the tank.

11. Size of Septic Tank:

For a family of six people, the septic tank should be no less than 2 feet 6 inches wide, 5 feet long, and no less than 4 feet deep. For larger families, it is a common practice to allow 5 to 6 cubic feet of tank content per person.

12. Location of Septic Tank

- a. A tank should be located not less than 20 feet from a cased well.
- b. Care should be taken not to locate it close to windows or doorways because of unpleasant odors that are likely to enter a structure.
- c. Soil most favorable for disposal of effluent is a sandy type. The tank must be installed close to the surface of the soil so the bacteria can thrive, which aids in oxidation of the effluent for more rapid purification.

13. Purification of discharged effluent:

- a. Dry-well -- A dry well is a hole in the ground curbed with material to allow the effluent to leach into the soil. It has low purification efficiency and is used primarily as a leaching or distributing unit. Dry wells are usually located more than 100 feet from any well or water source. It is normally 6 feet in diameter with a manhole extending above ground. (Transparency VII-4-0)
- b. Filter Trench -- This is an efficient purification unit and should be located close to the soil surface. It consists of a ditch 4 to 6 feet deep with the bottom at a slight slope. Common 4 to 6 inch drain tile is placed in the trench to serve as a collecting line. The end must be extended vertically above the soil surface. This allows for circulation of oxygen, which is important. The collection line is covered with 30 to 36 inches of gravel. It acts as a screen for suspended material and a source for aerobic bacteria that change suspended material into nitrogen compounds. A distributing line from the septic tank is laid directly over the collecting line. The length of

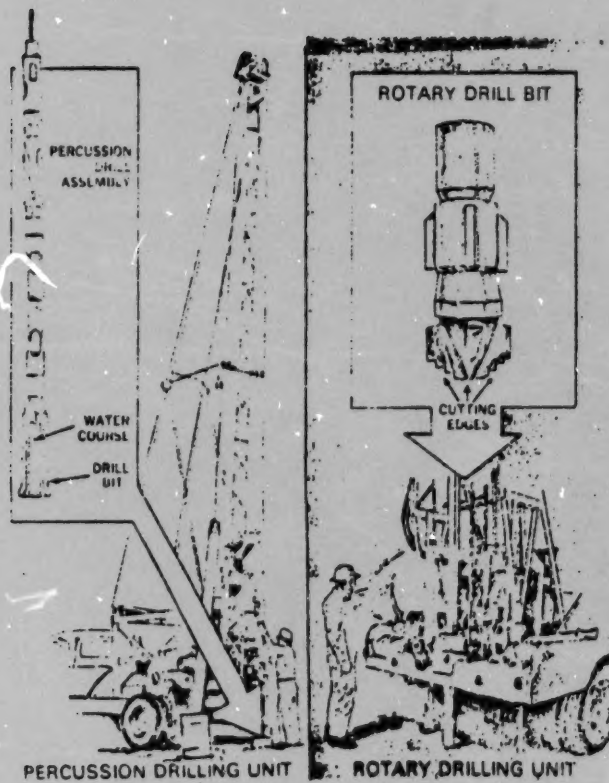
tile is estimated at a rate of 10 feet per person contributing to the tank. (Transparency VII-4-P)

- c. Distribution Field — This type of purification uses the ground as the means of purifying the discharge from the septic tank. This is useful when the soil is sandy, gravel, or sandy loam. It consists of open-jointed tile lines of no less than 4 inches in diameter. There is a main line with branches running off at 45 degree angles. The drain tile must be close to the soil surface into fresh air vents at the ends that extend about 4 inches above ground level. For sandy soil, allow 30 feet of tile per person or 50 feet for soil other than sand.

C. Suggested Student Activities

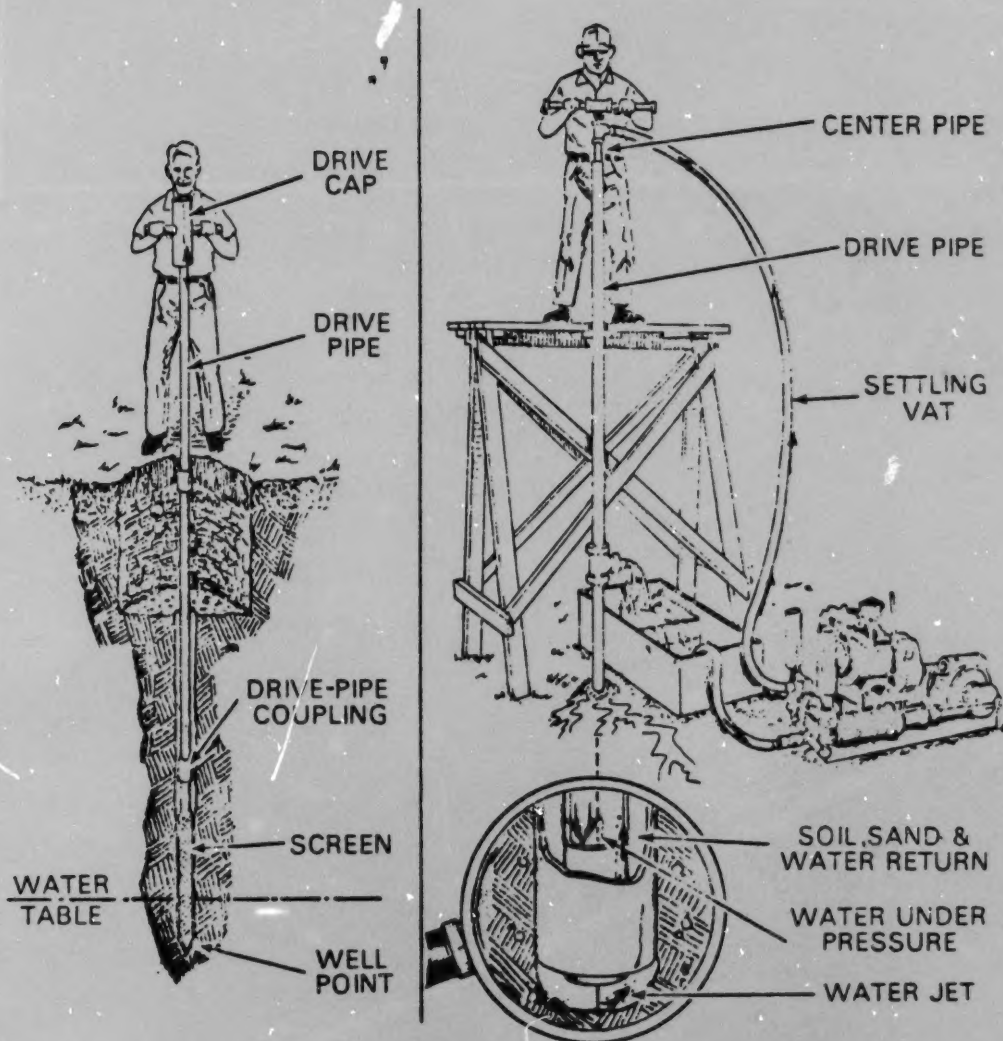
1. Students can draw diagrams/illustrations on poster board illustrating how a septic tank and its purification system works.
2. Students can give reports on the different types of pumps using a basic poster board drawing of the pump.

PERCUSSION DRILL ASSEMBLY



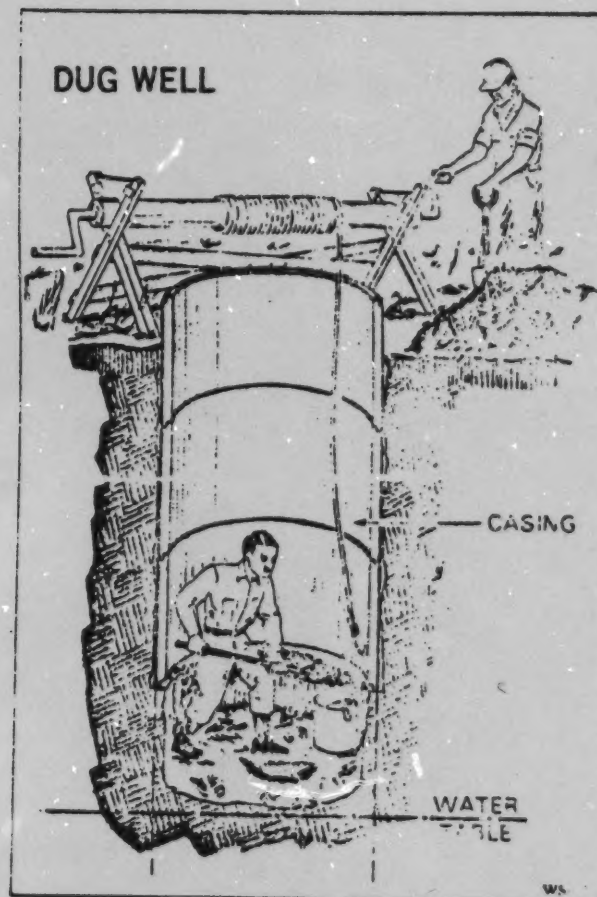
TRANSPARENCY VII-4-A

A DRIVEN WELL



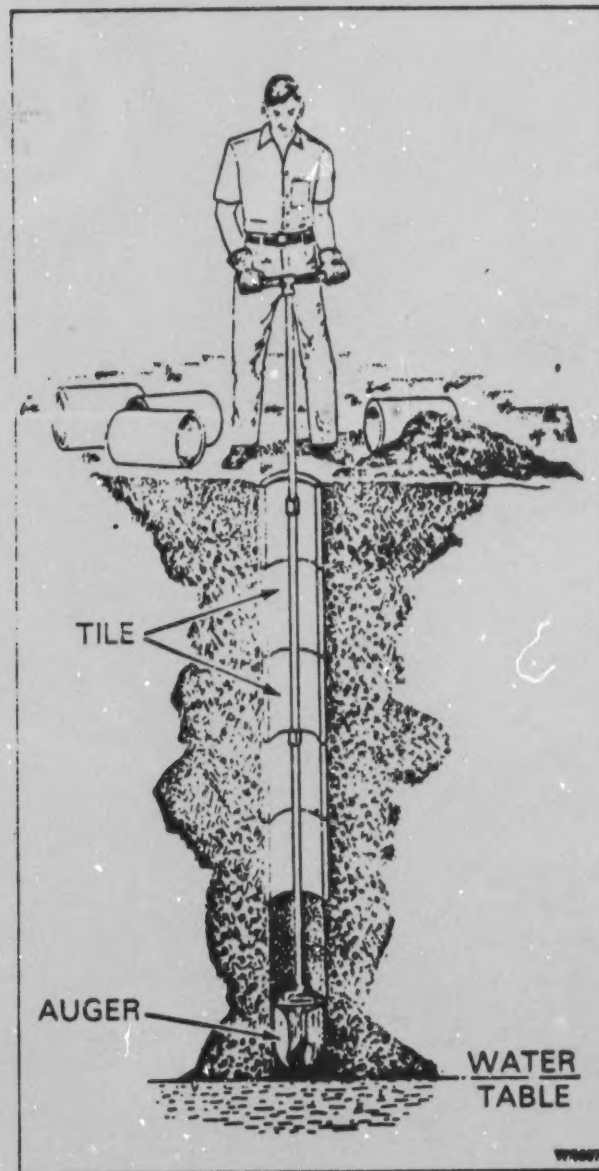
TRANSPARENCY VII-4-B

A DUG WELL



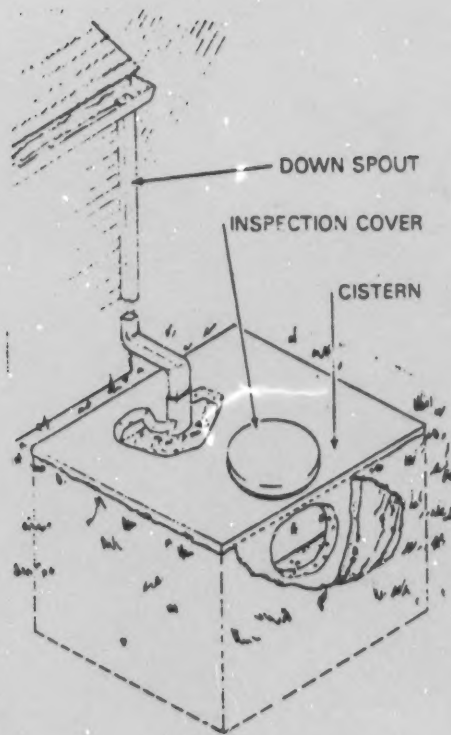
TRANSPARENCY VII-4-C

A BORED WELL



TRANSPARENCY VII-4-D

A CISTERN



TRANSPARENCY VII-4-E

PEAK DEMAND ALLOWANCE FOR HOME USES

	DEMAND ALLOWANCE GAL. PER MIN.
TUB AND SHOWER	2.0
2 LAVATORIES (.5 GPM EACH)	1.0
TOILET	.75
KITCHEN SINK	1.0
DISHWASHER	.5
CLOTHES WASHER	2.0

TRANSPARENCY VII-4-F

DETERMINE THE DEMAND ALLOWANCE FOR THE PUMP

	DEMAND ALLOWANCE GPM
LAWN OR GARDEN IRRIGATION (1 SPRINKLER)	2.5
AUTOMOBILE WASHING	2.5
ONE CLEANING-HOSE USE (FLOOR CLEANING)	5.0
TOTAL	10.0

TRANSPARENCY VII-4-G

DETERMINE THE PUMP CAPACITY NEEDED FOR
WATERING LIVESTOCK AND POULTRY

	DEMAND ALLOWANCE GPM
30 DAIRY CATTLE, OPEN HOUSING, FOUR WATERING SPACES (.75 GPM EACH)	3.00
40 HOGS, OPEN HOUSING, TWO WATERING SPACES (.15 GPM EACH)	.50
1,000 LAYING HENS, FIVE WATERERS (.12 GPM EACH)	.60

TRANSPARENCY VII-4-H

DETERMINE WHAT CAPACITY PUMP IS NEEDED

INDIVIDUAL FIXTURE FLOW RATE

HOME ONLY

TUBE AND SHOWER	8.0
2 LAVATORIES	1.0
TOILET	.75
KITCHEN SINK	1.0
DISHWASHER	.5
CLOTHES WASHER	2.0
	13.25

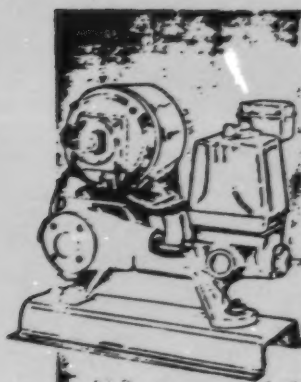
PEAK DEMAND ALLOWANCE

HOME, IRRIGATION AND CLEANING

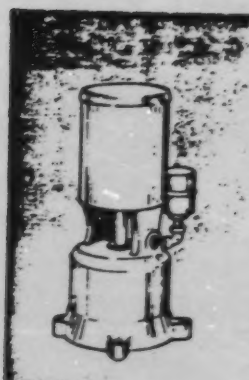
TUB AND SHOWER	2.0
2 LAVATORIES	1.0
TOILET	.75
KITCHEN SINK	1.0
DISHWASHER	.5
CLOTHES WASHER	2.0
LAWN OR GARDEN IRR.	2.5
AUTOMOBILE WASHING	2.5
1 CLEANING-HOSE USE	10.0
	22.25

TRANSPARENCY VII-4-I

TYPES OF PUMPS



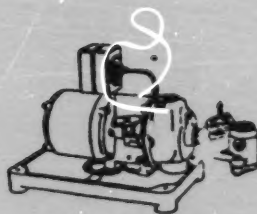
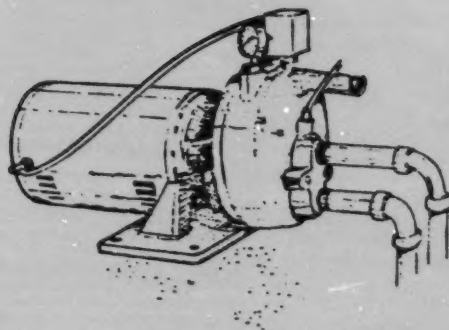
Piston Pump



Straight
Centrifugal**

TRANSPARENCY VII-4-J

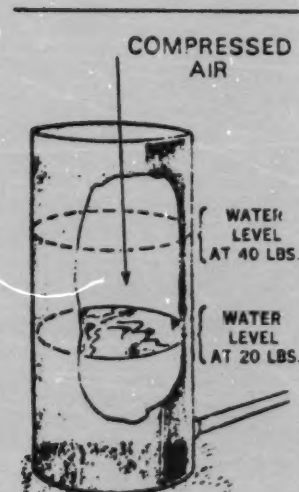
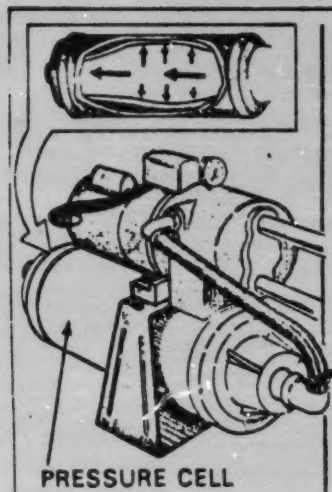
TYPES OF PUMPS



Shallow-well
Turbine

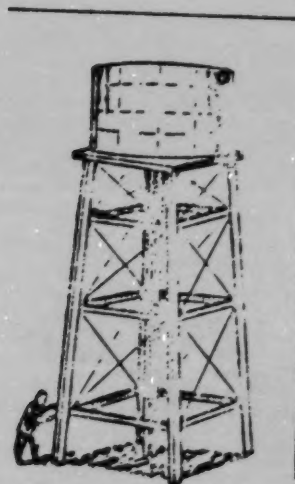
TRANSPARENCY VII-4-K

TYPES OF WATER STORAGE TANKS

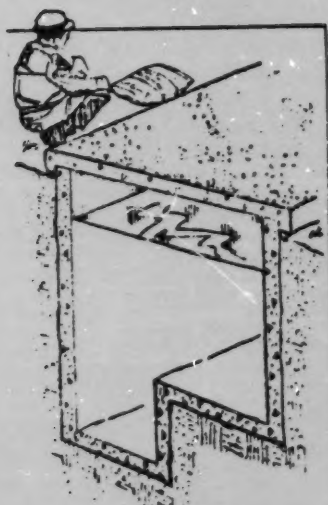


TRANSPARENCY VII-4-L

TYPES OF WATER STORAGE TANKS



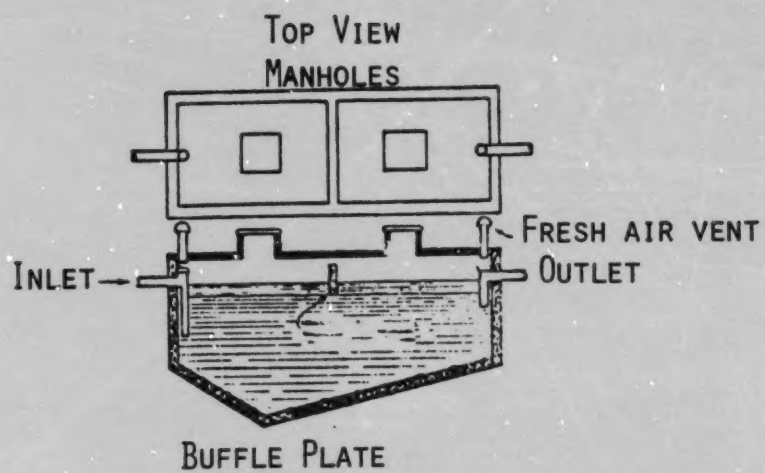
GRAVITY TANK



RESERVOIR

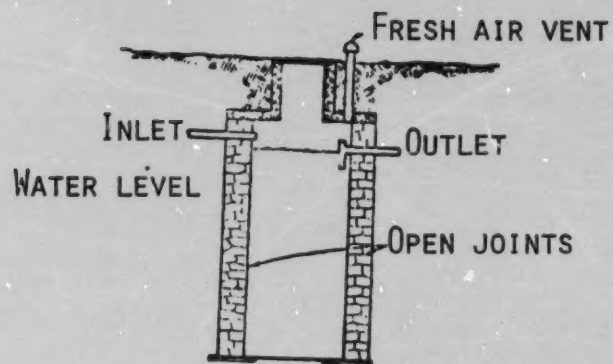
TRANSPARENCY VII-4-M

CROSS-SECTION OF SEPTIC TANK



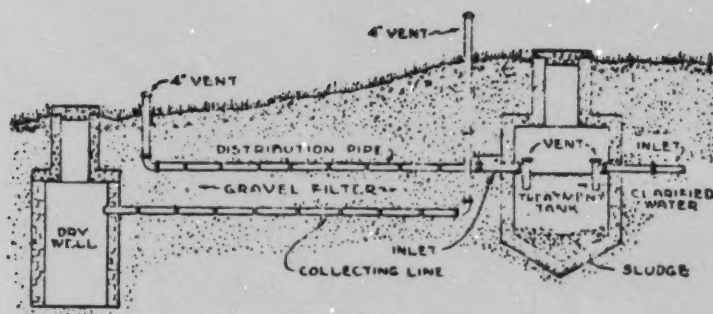
TRANSPARENCY VII-4-N

A DRY WELL FOR PURIFICATION



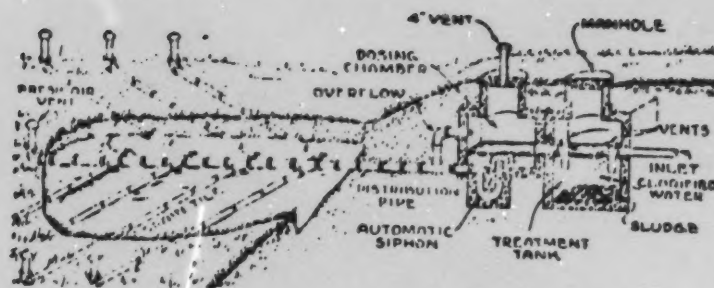
TRANSPARENCY VII-4-0

A FILTER TRENCH FOR PURIFICATION



TRANSPARENCY VII-4-P

A DISTRIBUTION FIELD FOR PURIFICATION



TRANSPARENCY VII-4-Q

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 5: Farm Surveying

I. Preparation for Instruction

A. Objectives

1. Terminal: Set up and operate a farm level.
2. Specific:
 - a. Describe the uses of the farm level.
 - b. Identify the parts of the farm level.
 - c. Demonstrate the procedure for leveling a farm level.
 - d. Demonstrate the use of the target rod.
 - e. Describe the process of staking out a building foundation.
 - f. Describe the process of staking out fence lines.
 - g. Demonstrate differential leveling.

B. Review of Teaching Material

1. Basic Vocational Agriculture IV. College Station, Texas, Vocational Instructional Services Center, Texas A&M University, 1978.
2. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: The Interstate Printers and Publishers, 1977.

C. Special Arrangements

Contact a local farmer to gain permission to conduct differential leveling on his farm.

D. Materials required

1. Farm levels
2. Philadelphia rod
3. Record books for field notes

II. Presentation of Lesson

A. Motivation

1. Discuss importance of leveling and squaring technique in building construction. In addition, farm levels assist rice farmers in marking rice levels.
2. Allow students to go outside of vocational agricultural building and lay out a 20 ft. x 20 ft. square for a building foundation without the aid of a farm level. Check squareness. Following this, the instructor will do the same thing with the aid of the farm level, emphasizing the difference in precision gained when using a farm level.

B. Content Outline

1. Use of farm level:

- a. Staking out fence lines,
- b. Farm pond layout,
- c. Layout of water control and drainage system, and
- d. Staking out building and structural foundation.

2. Parts of the farm level:

a. Turret type (Transparency VII-5-A)

- 1) Turret
- 2) Telescope tube
- 3) Graduated circle
- 4) Leveling plate
- 5) Slide screw
- 6) Slide tube
- 7) Leveling head
- 8) Tripod head
- 9) Leg bolts
- 10) Boss
- 11) Leveling screws

b. Utility type

- 1) Telescope
- 2) Level tube
- 3) Graduated circle
- 4) Index arm
- 5) Base plate
- 6) Tripod legs
- 7) Slide screw

- 8) Slide tube
- 9) Leveling screws
- 3. Setting up the farm level:
 - a. Set tripod legs firmly, $3\frac{1}{2}$ feet apart.
 - b. Secure level to tripod head.
 - c. Spike one tripod leg into the ground.
 - d. Turn telescope over spiked leg and one other leg. The second leg should be spiked into the ground, adjusting it until the bubble is visible in the level tube.
 - e. Turn level tube over the third leg, spike it into the ground and adjust until bubble is visible in the tube.
 - f. Tighten leg nuts on all tripod legs.
- 4. Leveling the farm level: (utility type)
 - a. Place telescope over two diagonally opposite leveling screws. Turn the screw an equal distance in opposite directions to center the bubble in the leveling tube.
 - b. Turn the telescope over the other two diagonally opposite leveling screws and repeat the process.
 - c. Repeat the process several times until the bubble remains in the center of the tube.
- 5. Use of target rod:
 - a. Types
 - 1) Philadelphia Rod -- This rod is graduated in feet, tenths, and hundredths. It has extensions so more height can be read.
 - 2) Architects Rod -- It has graduations just as the Philadelphia rod but is much lighter and shorter. It also has extensions.
 - 3) Self-Reading Rod -- This is used primarily for surveying land, running change lines, and soil conservation jobs.
 - b. The rod is used to measure elevation or heights of objects compared with the height of the instrument.

Grades are established by moving the target rod over the ground. When the grade is higher, lower numbers will be read on the rod and the opposite is true when the grade is lower.

- c. A rodman stands behind the rod and holds it in a vertical position. It should be placed on firm ground and not in a depression or a rise on the ground surface.

6. Staking out a foundation:

a. Rectangular foundation (Transparency VII-5-B)

- 1) This operation must be done from an established line such as the side of a building, a road, a property line, or other reference line. This is line AB.
- 2) Locate the point representing the lateral side limit for a front corner (c) of the structure.
- 3) Set up level at point C and sight to point E. Turn the telescope 90° and establish point D, a front corner of the structure.
- 4) Move instrument to point E. This is a greater distance along AB than the intended length of the structure. Sight back at C, turn the telescope 90° and set a stake at point F. Point F should be the same distance from AB as D. Therefore, CD equals AB.
- 5) The frontline of the building is established by marking off the length of DG along line DF.
- 6) Return the instrument to point C. Sight point F, turn the instrument 90° and sight along this line to establish H, a rear corner of the building.
- 7) Move level and set up at G, sight D, and swing the telescope 90° . Identify I, the other rear corner of the structure.
- 8) To check work, measure IH. It should be equal to DG.

b. Irregular shaped structure (Transparency VII-5-B)

- 1) Lay out main rectangle first.
- 2) Small rectangles are then laid out.

- 3) Points and measurements should be checked on all rectangles.

c. Setting up batter boards

- 1) Batter boards are horizontal boards fastened to small posts placed near the corners of the proposed structure. They will be used to mark the outline of the building. (Transparency VII-5-C)
- 2) Stake out corners as located in above procedure. Drive a nail in the top of each stake to indicate the outside line of the foundation walls.
- 3) Three 2x4 boards of suitable length are driven at each location about 4 feet beyond the lines of the function. The 1x6 boards are nailed horizontally so the tops are level.
- 4) Hold some stout twine over the tops of opposite boards at two corners and adjust it so it is exactly over the nails in the corner stakes at either end. Fasten string to batter boards. Be sure to mark the string location on the batter boards so they can be replaced easily if broken. (Transparency VII-5-D)

7. Staking out a fence line (Transparency VII-5-E)

- a. Set up the instrument with the plumb bob bisecting a corner stake of a completely new fence. Point telescope in the direction of the fence line, and place the graduated circle at zero degrees. Align all stakes with the vertical crosshair.
- b. When all stakes are aligned in one fence line, turn the telescope 90°. This will be the other proposed fence line that will intersect at the corner. Align stakes with the telescope and measure the distances with a measuring tape.

8. Differential leveling (Transparency VII-5-F)

- a. Differential leveling is used to determine the relative differences in elevation at different points on a farm. This is useful in running drainage lines and constructing soil conservation structures. Permanent, known elevation points are called bench marks. A bench mark can be a boulder, concrete slab, or some other permanent spot. It is used as a reference point to determine elevation of

unknown points. In most farm surveys, the elevation of the first bench mark is assumed to be 100 feet and other elevations are determined in relation to this bench mark.

- b. Set up the instrument at a distance away from BM-1 toward BM-2 not farther than 350 feet. The level should be located near the center of two readings, BM-1 and TP-1 for example. (Transparency VII-5-F and VII-5-G)
- c. Take a reading on BM-1 and record it in the field notes (Transparency VII-5-H) to be carried with the reader. This reading is called the backsight. This is added to the last known height to give the elevation of the line of sight, called the height of the instrument (HI).
- d. The next reading is taken at TP-1 where a temporary stake is set. It is called a foresight (FS). It is of unknown elevation and subtracted from HI. This now becomes a known elevation and the instrument is moved between TP-1 and TP-2 to take a backsight on TP-1.
- e. This survey is continued until the last FS is taken at BM-1.
- f. There is usually a small amount of error between the final reading and the assumed elevation of BM-1 at 100 feet. This allowable error is determined by:

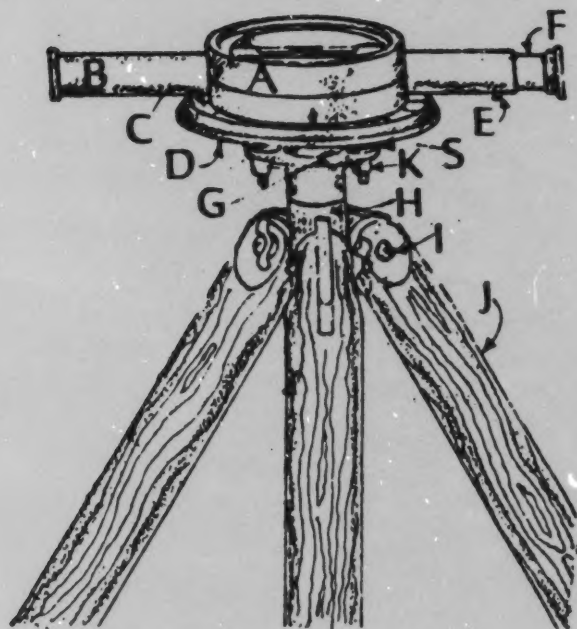
Allowable error = .014 times the square root of the lengths of the traverse in feet divided by 100.

- g. Field notes must be kept in differential leveling. Examples are shown in the transparency. (Transparency VII-5-H)
 - 1) Record a descriptive title at the top of the first page for each job.
 - 2) Use 3H or 4H hard lead pencil. Never use ink.
 - 3) Information should be filled in immediately, accurately, and neatly.
 - 4) Put all information in the proper column and row.

C. Suggested Student Activities

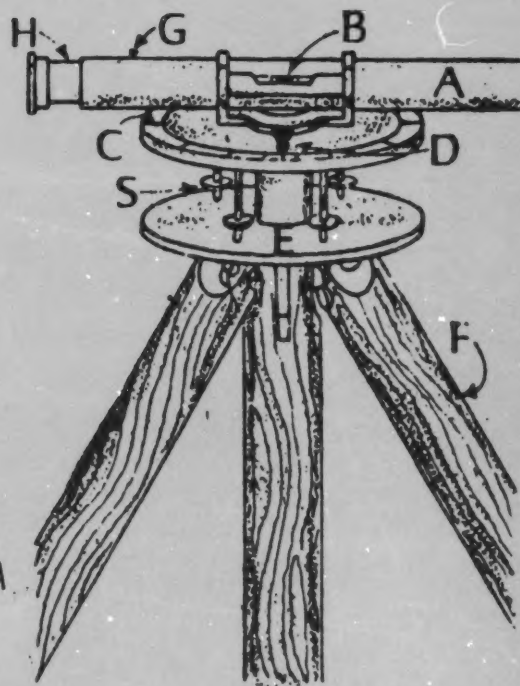
1. Arrange for a field trip to a farm to do an exercise on differential leveling. This may be arranged to coincide with a need a farmer may have in this area.
2. Provide students with equipment to lay out a simple rectangular structure and an irregularly shaped structure.

PARTS OF FARM LEVELS



TURRET TYPE

- A - TURRET
- B - TELESCOPE TUBE
- C - GRADUATED CIRCLE
- D - LEVELING PLATE
- E - SLIDE SCREW
- F - SLIDE TUBE
- G - LEVELING HEAD
- H - TRIPOD HEAD
- I - LEG BOLTS
- J - TRIPOD LEGS
- K - BOSS
- S - LEVELING SCREWS

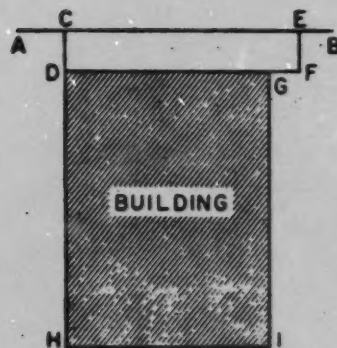


UTILITY TYPE

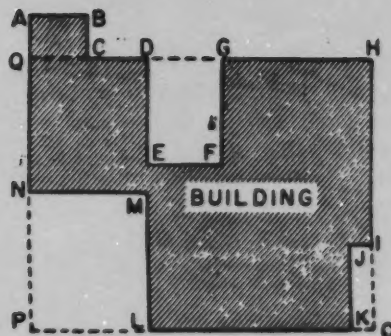
- A - TELESCOPE
- B - LEVEL TUBE
- C - GRADUATED CIRCLE
- D - INDEX ARM
- E - BASE PLATE
- F - TRIPOD LEGS
- G - SLIDE SCREW
- H - SLIDE TUBE
- S - LEVELING SCREWS

TRANSPARENCY VII-5-A

LAYOUT OF A SIMPLE RECTANGLE

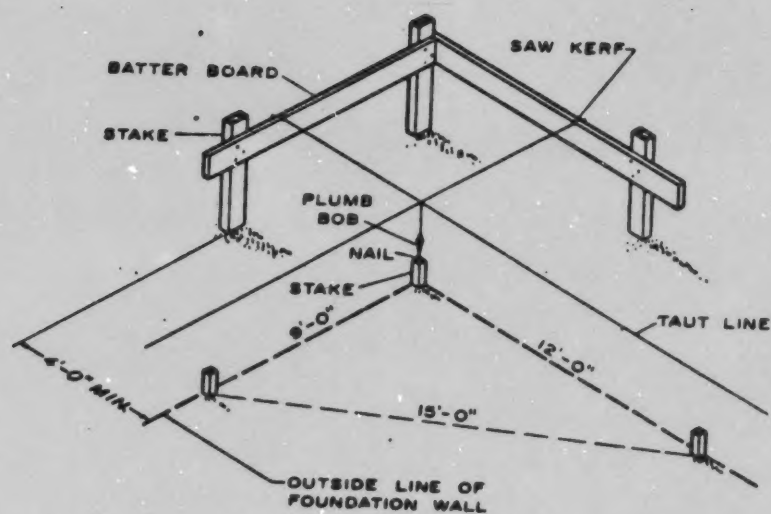


LAYOUT ON AN IRREGULARLY SHAPED BUILDING



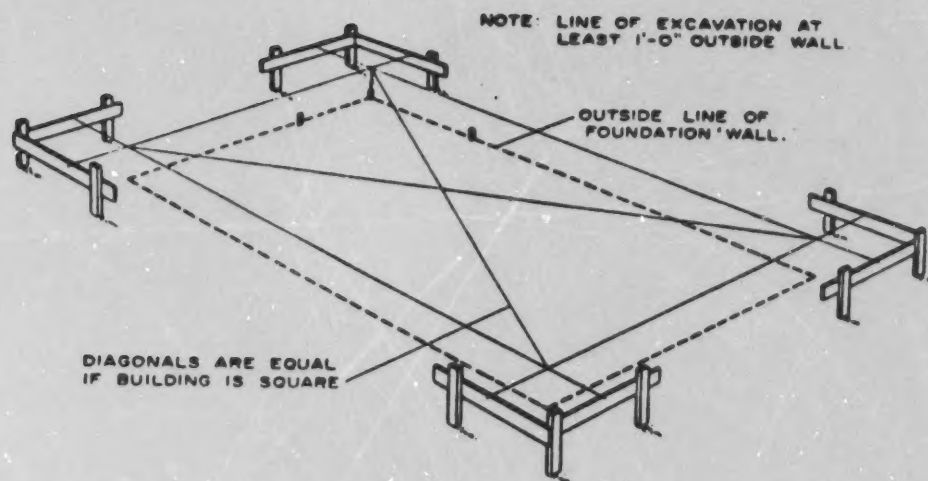
TRANSPARENCY VII-5-B

LOCATING OUTLINE OF STRUCTURE



TRANSPARENCY VII-5-C

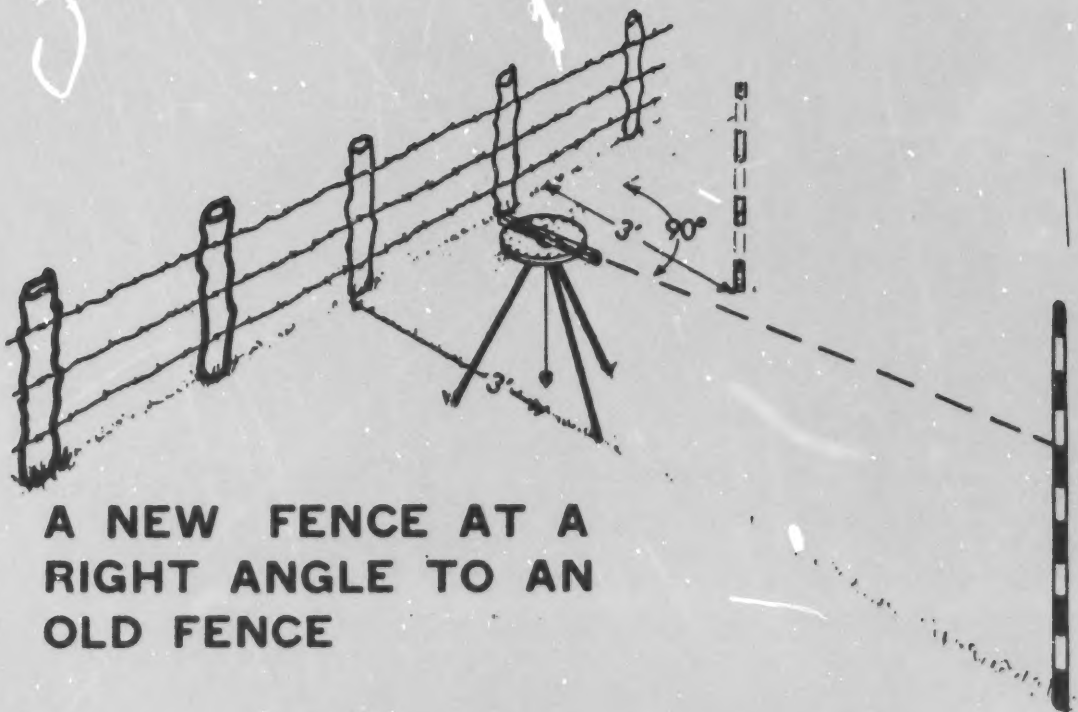
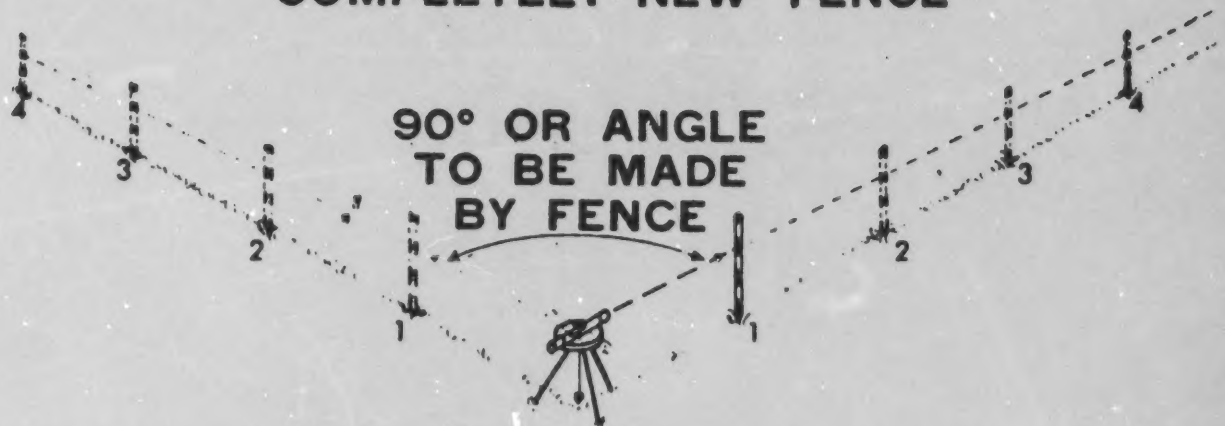
FINDING OUTLINE OF STRUCTURE USING BATTER BOARDS



TRANSPARENCY VII-5-D

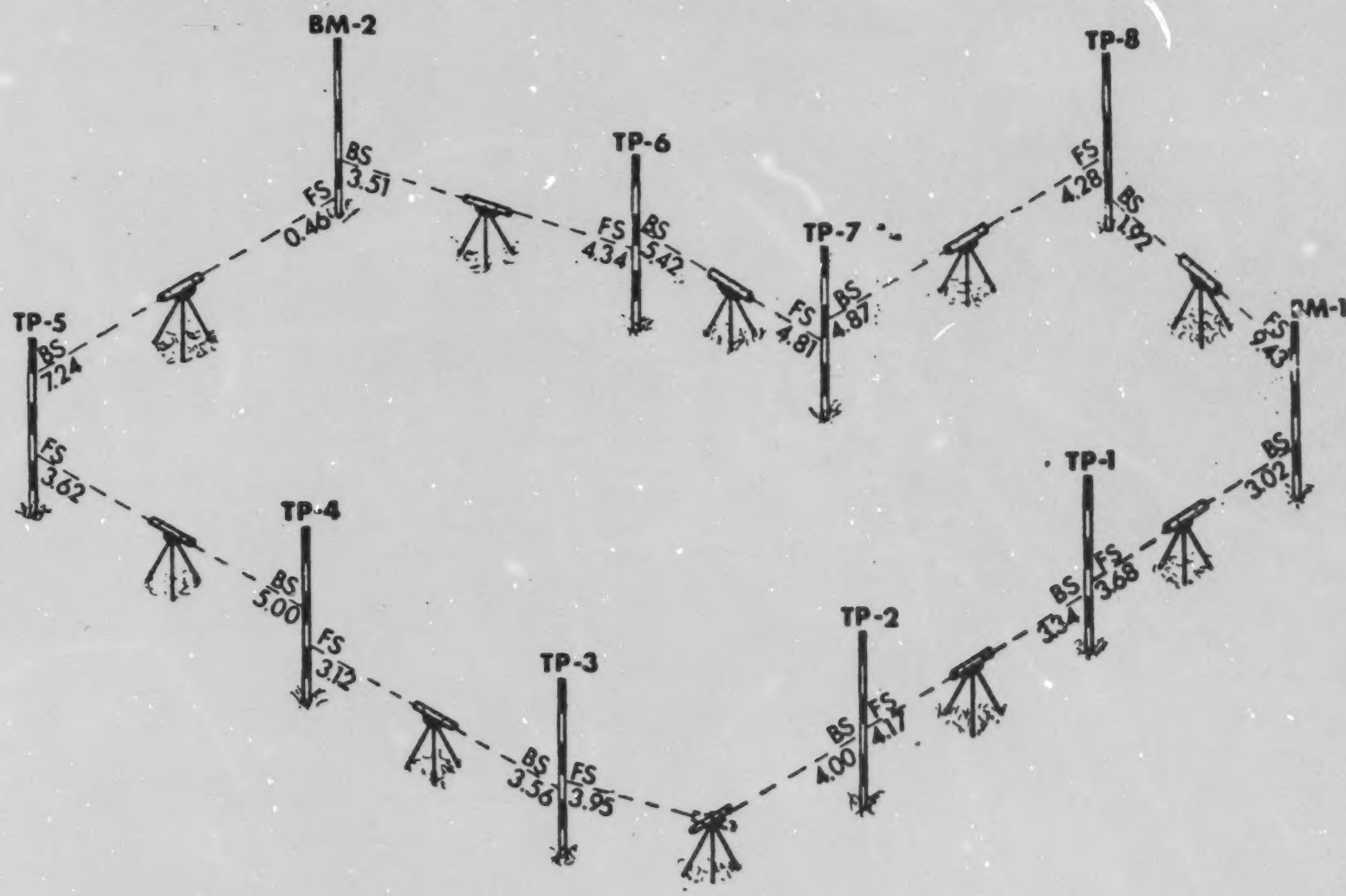
STAKING OUT FENCE LINES

COMPLETELY NEW FENCE



A NEW FENCE AT A
RIGHT ANGLE TO AN
OLD FENCE

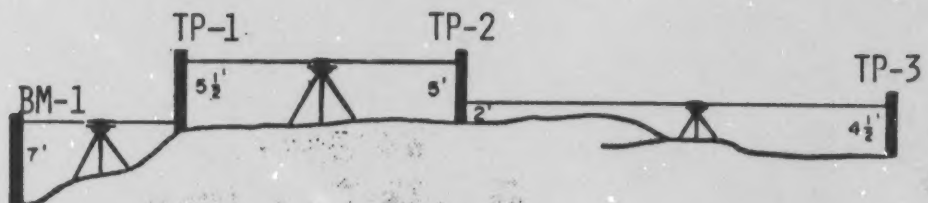
AN EXAMPLE OF DIFFERENTIAL LEVELING



TRANSPARENCY VII-5-F

353

DIFFERENTIAL LEVELING



TRANSPARENCY VII-5-G

DIFFERENTIAL LEVELING FIELD NOTES

Differential Leveling

Sta.	BS	HI	FS	Elev.	Dist.
BM-1	3.02			100.00	
		103.02			250
TP-1	3.34		3.68	99.34	
		102.68			270
TP-2	4.00		4.17	98.51	
		102.51			330
TP-3	3.56		3.95	98.56	
		102.12			300
TP-4	5.00		3.12	99.00	
		104.00			320
TP-5	7.24		3.62	100.38	
		107.62			370
BM-2	3.51		0.46	107.16	
		110.67			320
TP-6	5.42		4.34	106.33	
		111.75			280
TP-7	4.87		4.81	106.94	
		111.81			310
TP-8	1.92		4.28	107.53	
		109.45			260
BM-1			9.43	100.02	
					3010
		Error - 0.02'			

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 6: Farm Plumbing

I. Preparation for Instruction

A. Objectives

1. Terminal: Measure, cut, and join plumbing pipe.
2. Specific:
 - a. Identify common plumbing fittings and pipe.
 - b. Identify common plumbing tools.
 - c. Identify types of plumbing pipe.
 - d. Describe how to select plumbing pipe.
 - e. Demonstrate how to measure plumbing pipe.
 - f. Demonstrate the technique for cutting plumbing pipe.
 - g. Demonstrate the process of threading galvanized and black pipe.
 - h. Demonstrate the technique for flaring copper tubing.
 - i. Describe the process of soldering fittings onto copper tubing.
 - j. Demonstrate cutting and joining plastic pipe.

B. Review of Teaching Material

1. Basic Vocational Agriculture III. College Station, Texas: Vocational Instructional Services Center, Texas A & M University, 1978.
2. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: The Interstate Printers and Publishers, Inc., 1977.

C. Special Arrangements

1. Prior arrangements for a field trip to a local plumbing store to observe the various tools, equipment, and supplies.
2. Obtain galvanized or black pipe, copper tubing, and plastic pipe for class exercises. Also, obtain the proper glue, solder, and other supplies for joining pipe.

II. Presentation of Lesson

A. Motivation

Use examples of poorly measured, cut, and joined pipe to illustrate the importance of this work being done properly.

B. Content

1. Plumbing fittings:

a. Pipe fittings are used to...

- 1) Connect pipe,
- 2) Change the direction of pipe,
- 3) Reduce the size of pipe, and
- 4) Plug pipe.

Pipe fittings are made for all types of plumbing pipe.

b. Types of fittings (standard) (Transparency VII-6-A)

- 1) Tee
- 2) 90° ell
- 3) 45° ell
- 4) Coupling
- 5) Cross
- 6) Ground-joint Union
- 7) Reducing tee
- 8) Reducer
- 9) Pipe cap
- 10) Plug
- 11) Close nipple
- 12) Short nipple
- 13) Long nipple
- 14) 90° Reducing ell
- 15) 90° Street ell
- 16) 45° Street ell
- 17) Bushing

- 18) Tank nipple
- 19) Extension piece
- 20) Floor flange
- 21) Drop-ear ell
- 22) Street tee

c. Pipe fittings for copper, cast iron, and plastic pipes are shown in Transparencies VII-6-B and C.

2. Plumbing tools: (Transparencies VII-6-D, E, and F)

- a. Pipe vise -- This type of vise is specially made for use in securing different sizes of pipe while cutting and threading procedures are in progress. It should be noted this vise is different from a regular type of shop vise.
- b. Pipe cutter -- This cutter is much more desirable than using a hacksaw to cut pipe since it cuts smoother, quicker, and straighter.
- c. Stocks and dies -- These are the tools used to thread the pipe after cutting. The dies are interchangeable in the stocks so that different sized pipe may be threaded.
- d. Pipe wrenches -- Several sizes and types of wrenches are available. Usually two wrenches are needed to tighten and loosen pipes and fittings.
- e. Burring reamer -- When a pipe is cut, burrs are made on the end and can be removed with a reamer.
- f. Flaring tool -- The flare tool is used to form a flare on the ends of copper tubing when flare types of fittings are used.
- g. Tube cutter -- The tube cutter is used to cut copper and similar types of pipe which are too small to be cut with a pipe cutter.

3. Types of plumbing pipe

- a. Galvanized -- This has been the most commonly used plumbing pipe for farm use. It will last 30 to 40 years under normal conditions. One-eighth inch in diameter is the smallest size, while 12 inches is the largest. Pipe size is determined by inside pipe diameter, not outside diameter.

- b. Black steel pipe -- This pipe is most commonly used for gas lines. It is not used for most plumbing jobs because it corrodes easily.
 - c. Copper pipe -- Copper tubing comes in two kinds: Type K--heavy duty, and Type L--the standard copper pipe. It will normally last from 40 to 100 years. It is purchased in 25-foot coils and is sized from 1/8 inch to 1 inch in diameter.
 - d. Plastic pipe -- There has been a dramatic increase in the use of plastic pipe. It is easily laid and does not require any special tools. The pipe is joined with a special glue. Initially, plastic pipe was not used for hot water. However, plastic pipe can be purchased for hot water use but must be specially asked for when buying. Plastic pipe is available in rigid 10 foot sections or in 60 foot coils. The coiled pipe is not recommended for inside home use.
 - e. Cast iron pipe -- This pipe is used for drains and vents. It ranges in size from 2 to 12 inches in diameter. It does not corrode and will last indefinitely.
4. Factors to consider in pipe selection:
- a. Mineral or chemical content of the water,
 - b. Resistance to corrosion,
 - c. Life expectancy,
 - d. Recommended pressure,
 - e. Resistance to deposits,
 - f. Use of the pipe,
 - g. Lengths available, and
 - h. Cost.
5. Measuring pipe -- The most accurate method for measuring the amount of pipe needed between two fittings is to measure the distance from the center of one pipe to the center of the other pipe, then, subtract the diameter of the pipe for each thread. For example, a farmer using one-inch pipe would subtract two inches from the length of the pipe, one for each end of the pipe. (Transparency VII-6-G)

6. Cutting pipe: (Transparency VII-6-H)
 - a. Fasten the pipe in the vise with the measuring mark four inches in front of the vise.
 - b. Slip the opened pipe cutter over the pipe and turn the handle until the wheels are snug against the pipe at the mark.
 - c. Place some cutting oil on the mark.
 - d. Turn the pipe cutter around the pipe, screwing the handle in one-fourth turn per revolution around the pipe until it is cut off.
 - e. Remove burrs that are left inside the pipe. (Transparency VII-6-I)
7. Threading galvanized and black pipe: (Transparency VII-6-J)
 - a. Clean pipe of rust, dirt, and other material.
 - b. Remove any burrs made from cutting the pipe.
 - c. Secure pipe in a pipe vise.
 - d. Apply cutting oil to the die.
 - e. Apply inward pressure on the die as it is turned on the pipe until die is engaged on the pipe.
 - f. Apply oil frequently to the pipe just ahead of the die.
 - g. Continue to thread pipe until one thread is showing outside of the die. More threads should show on large pipe. Do not turn the die backwards and forwards because this will damage the threads.
 - h. Back the die off carefully. If it catches, turn the die forward to dislodge metal chips.
 - i. Clean oil from the pipe and remove the pipe from the vise.
8. Flaring copper tubing: (Transparency VII-6-K)
 - a. Slip a sleeve nut on the copper tubing.
 - b. Wrap tubing with cloth and place in a vise.
 - c. Apply a few drops of oil to the flaring tool.

- d. Place flaring tool over the end of the tubing and place tubing flush with the tool surface.
- e. Screw the flaring tool into the end of the tubing to make a flare.
- f. Remove the tool and slip the sleeve nut in position. It is now ready to be placed on the fitting.

9. Sweating joints on copper tubing:

- a. Cut copper tubing and remove burrs.
- b. Clean thoroughly the area of the tubing to be covered by the fitting. Also clean the inside of the fitting.
- c. Apply flux to the clean portion.
- d. Place the fitting on the tubing until it is firmly against the shoulder of the fitting. Turn several times to distribute the flux.
- e. Apply heat until the flux melts and the copper will melt the solder.
- f. Apply solder to the edge of the fitting until the solder fills the joint by capillary action. Remove the flame as soon as the joint is filled with solder.
- g. Allow the joint to cool.

10. Cutting and joining plastic pipe:

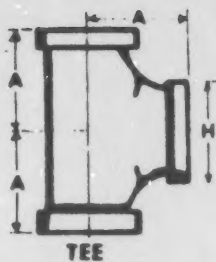
- a. Cut pipe with a hacksaw to the desired length.
- b. Cut off residual shavings with a pocket knife.
- c. Clean the portion of pipe to be covered by the pipe and inside of the fitting with a special cleaning solvent.
- d. Apply special glue to the surface of the pipe and inside of the fitting.
- e. Push the pipe into the fitting until it contacts the shoulder of the fitting. Turn the pipe $\frac{1}{4}$ turn to distribute the glue in the joint.

C. Suggested Student Activities

1. Have student draw a poster mural illustrating the different types of plumbing fittings.
2. Allow three assigned groups of students from class to construct a board with the various types of fittings for an assigned type of pipe. One group will take galvanized pipe, one group will take copper tubing, and the other group will take plastic pipe.
3. Construct a plumbing project and check to determine if any leaks are present. This project should consist of a $2\frac{1}{2}$ foot by $2\frac{1}{2}$ foot square made of various sized pipe and fittings with a faucet attached.

KINDS OF PIPE FITTINGS

STANDARD FITTINGS



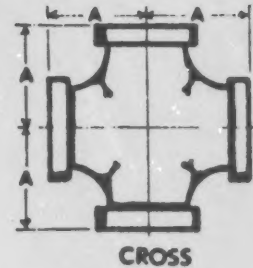
TEE



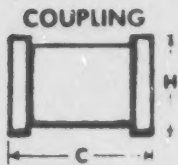
90° ELL



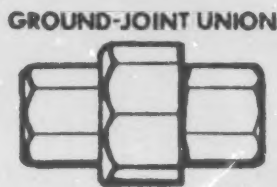
45° ELL



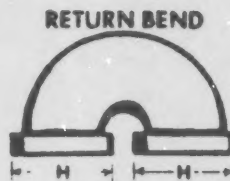
CROSS



COUPLING



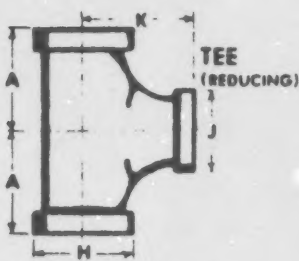
GROUND-JOINT UNION



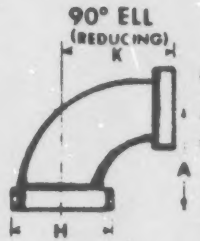
RETURN BEND



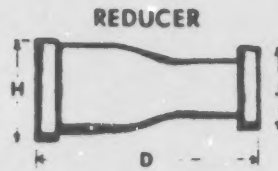
EXTENSION PIECE



TEE (REDUCING)



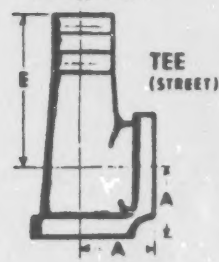
90° ELL (REDUCING)



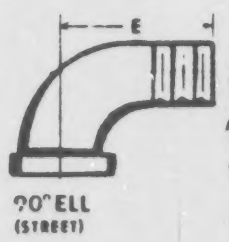
REDUCER



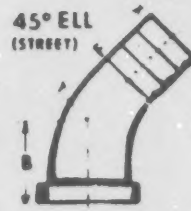
PIPE CAP



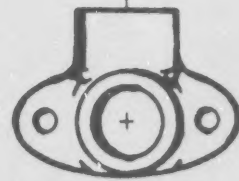
TEE (STREET)



90° ELL (STREET)



45° ELL (STREET)



DROP-EAR ELL



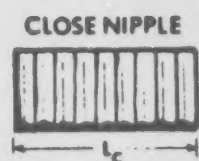
FLOOR FLANGE



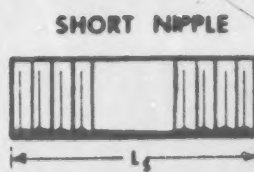
PLUG



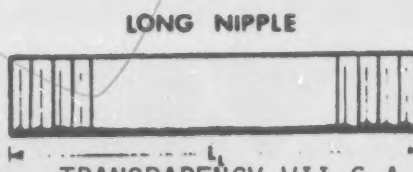
BUSHING



CLOSE NIPPLE



SHORT NIPPLE



LONG NIPPLE

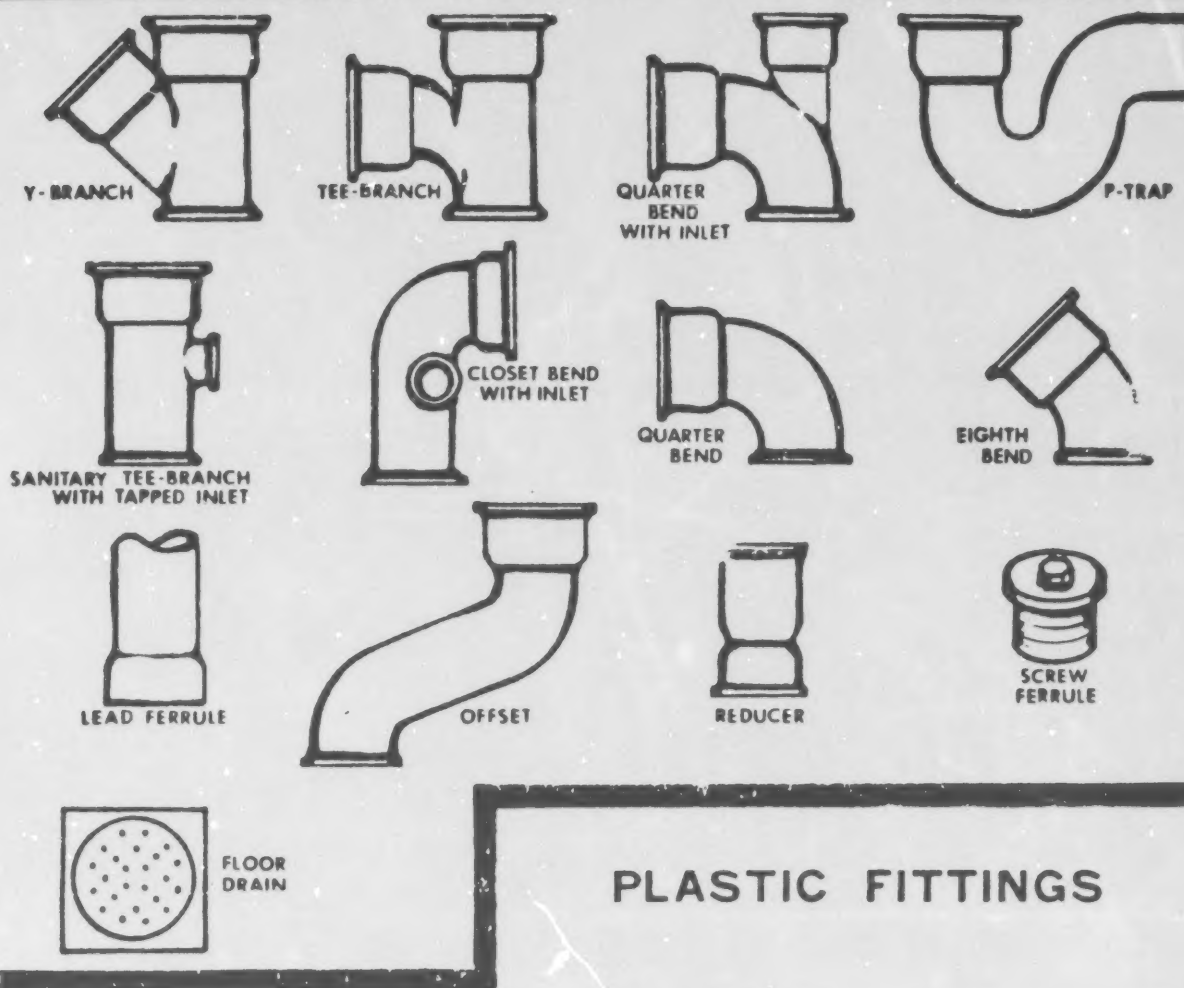


TANK NIPPLE

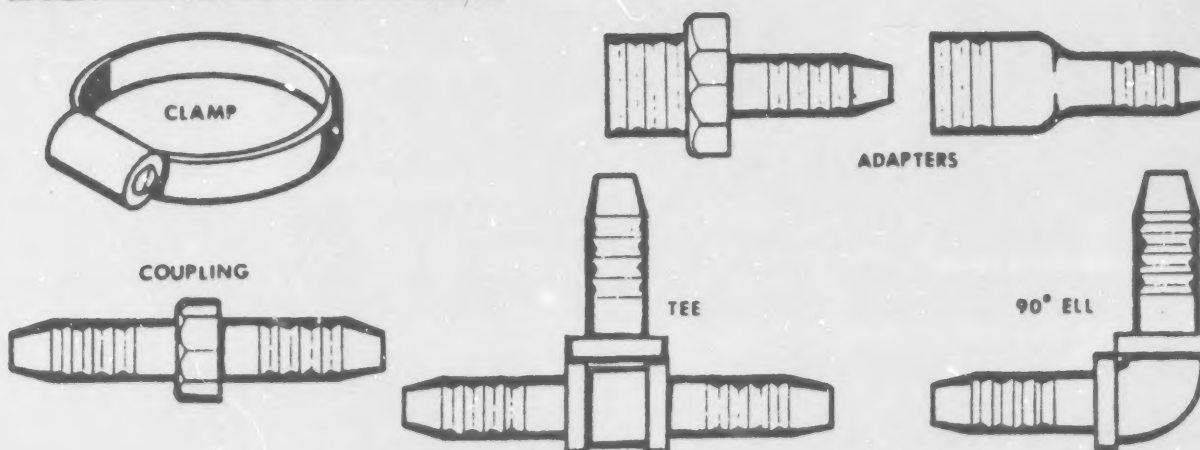
TRANSPARENCY VII-6-A

KINDS OF PIPE FITTINGS

CAST IRON FITTINGS



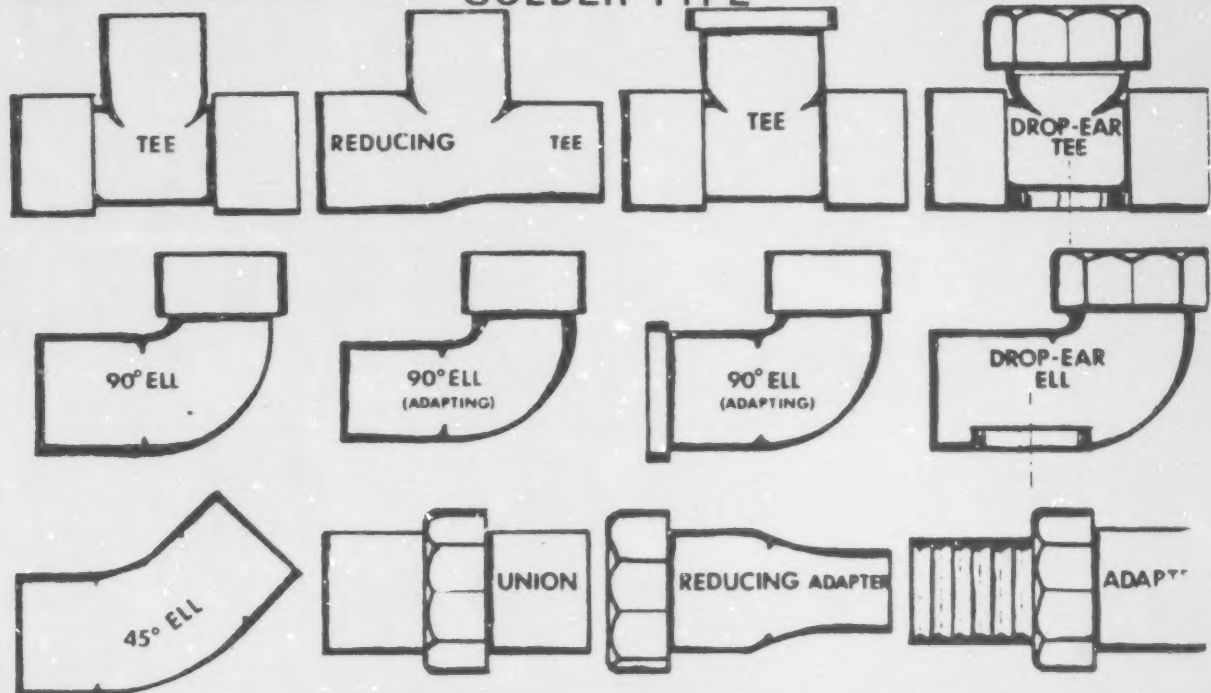
PLASTIC FITTINGS



TRANSPARENCY VII-6-B

KINDS OF PIPE FITTINGS COPPER FITTINGS

SOLDER TYPE



COUPLING

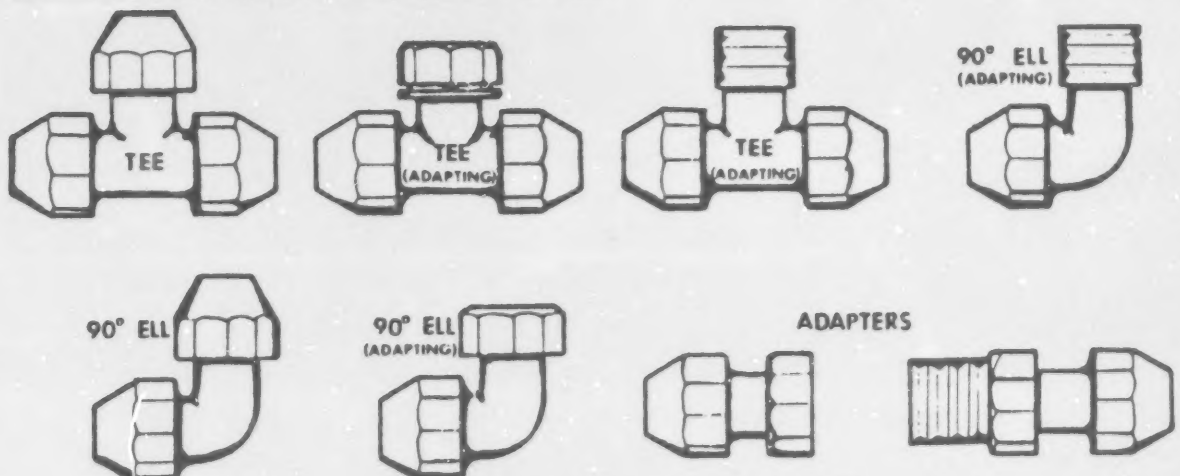
FLUSH
BUSHING

END
CAP

FLARE TYPE

FLARING
TOOL

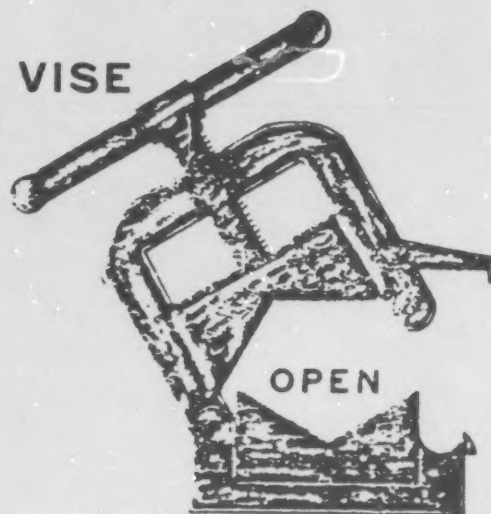
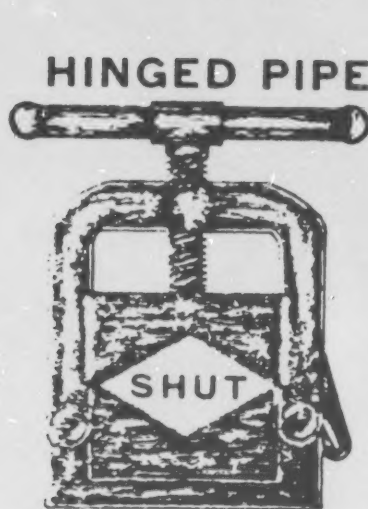
UNION



TRANSPARENCY VII-6-C

PLUMBING TOOLS

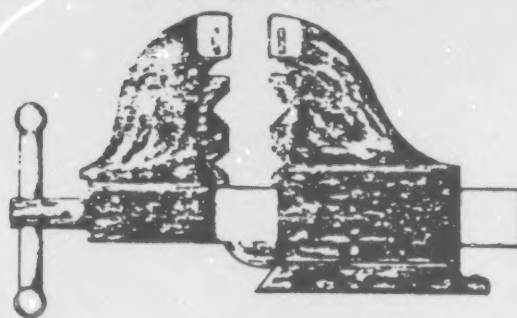
HINGED PIPE VISE



CHAIN PIPE VISE



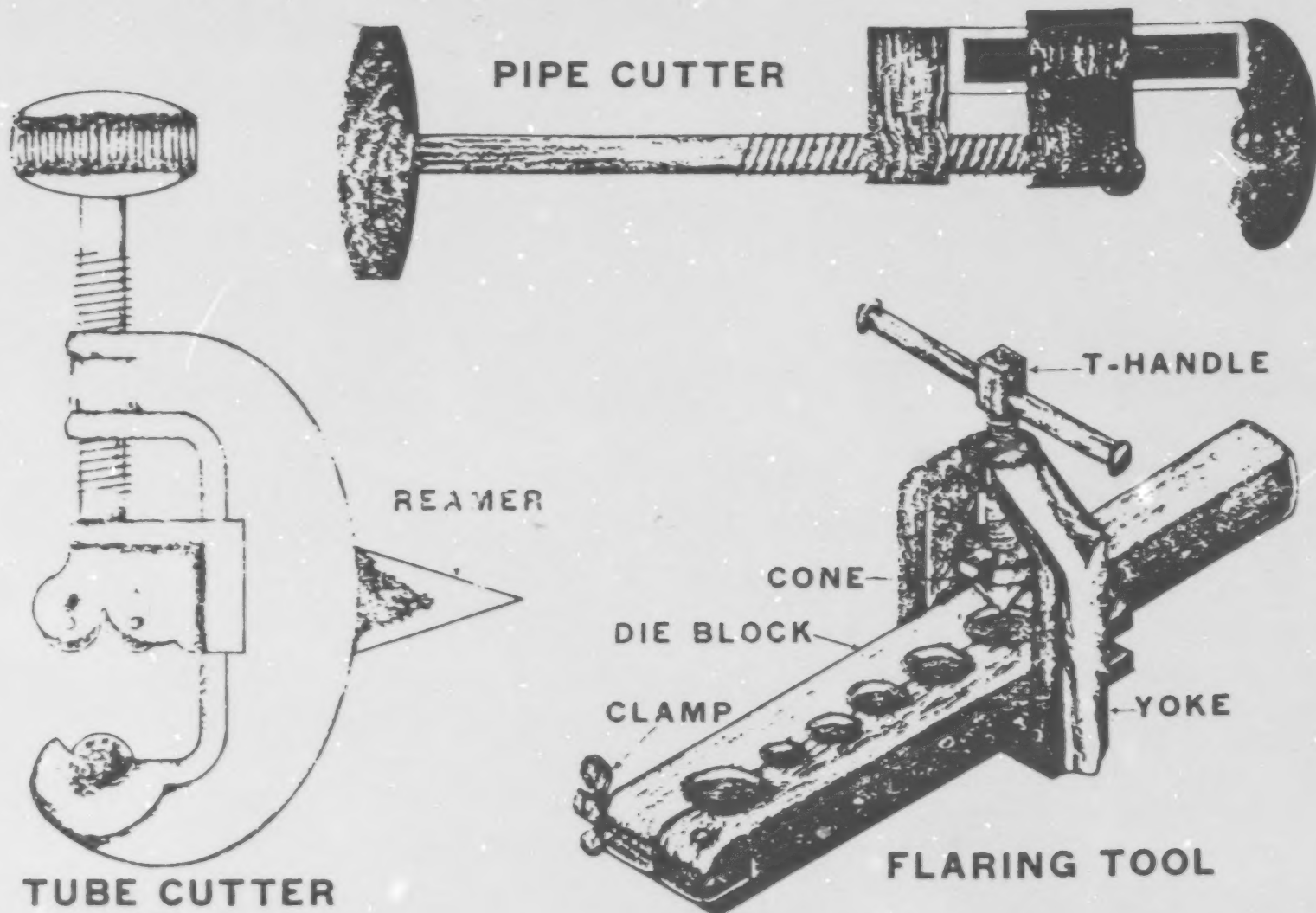
COMBINATION
PIPE VISE



BURRING REAMER



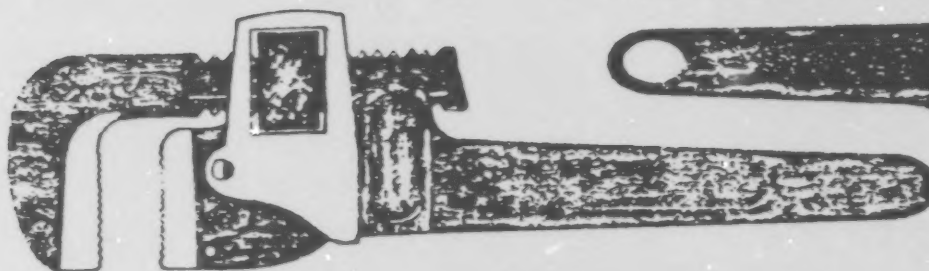
PLUMBING TOOLS



TRANSPARENCY VII-6-E

PLUMBING TOOLS

PIPE WRENCHES

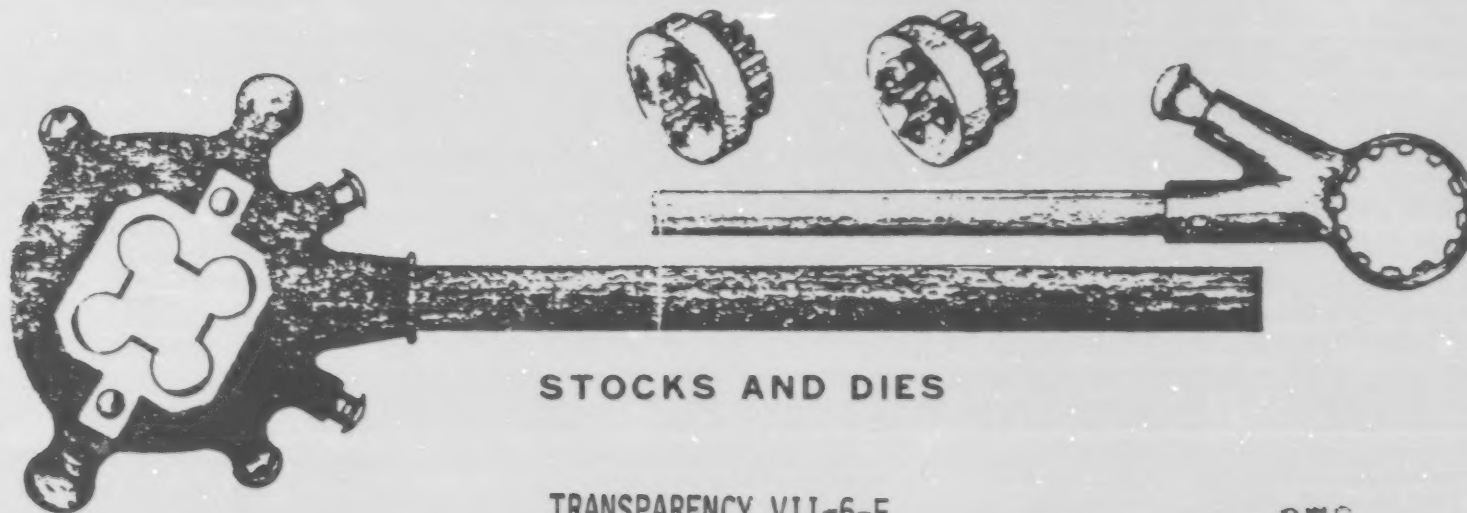


SIZES 6 TO 48 INCHES



SIZES 6 TO 36 INCHES

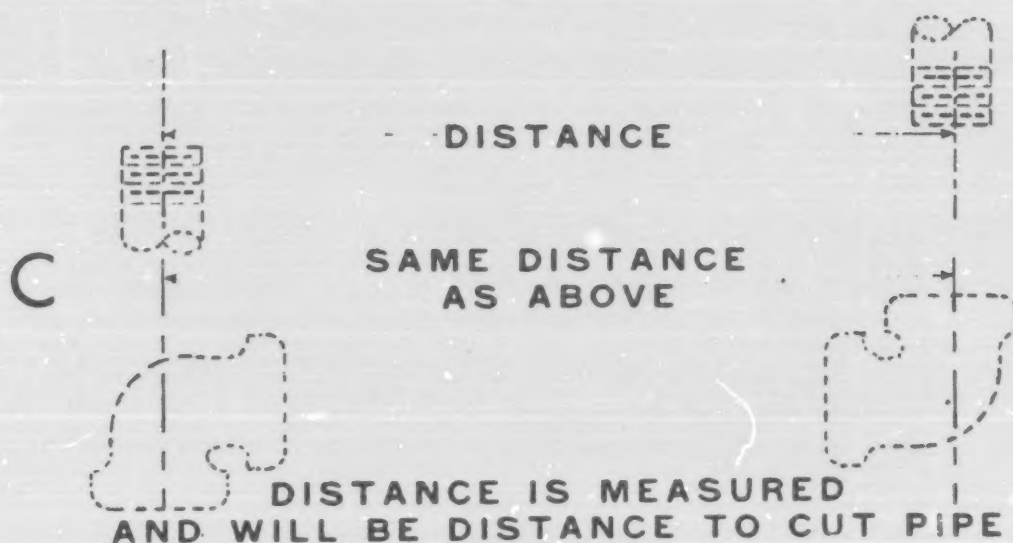
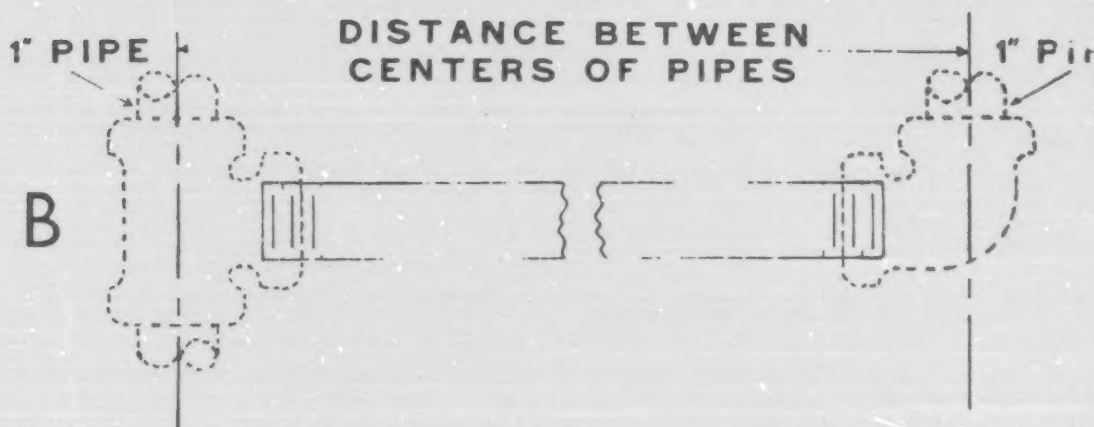
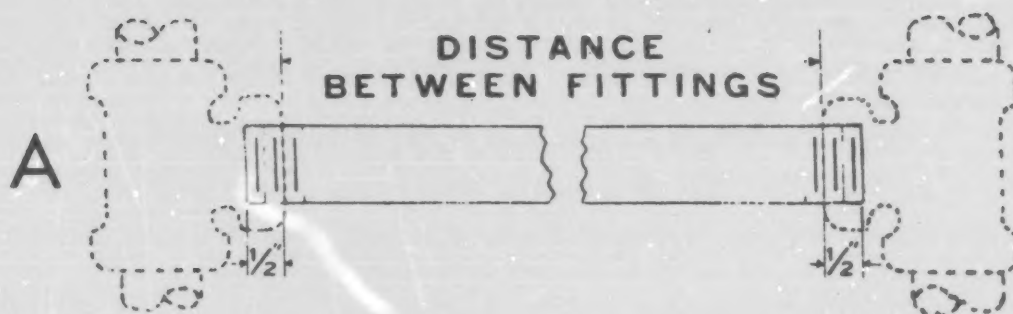
PIPE THREADERS



STOCKS AND DIES

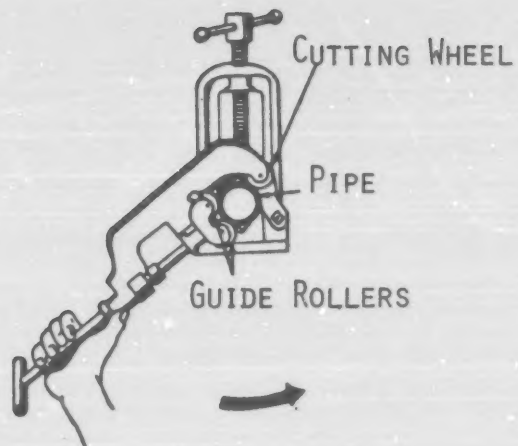
TRANSPARENCY VII-6-F

MEASURING PIPE



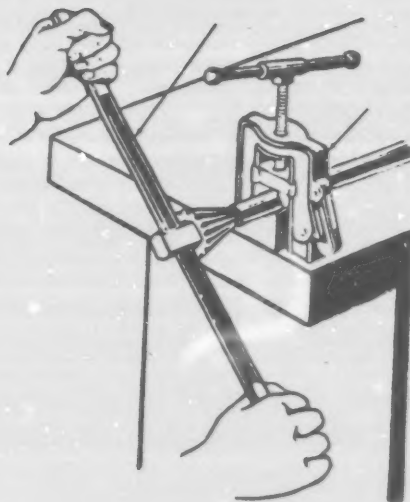
TRANSPARENCY VII-6-G

CUTTING PIPE



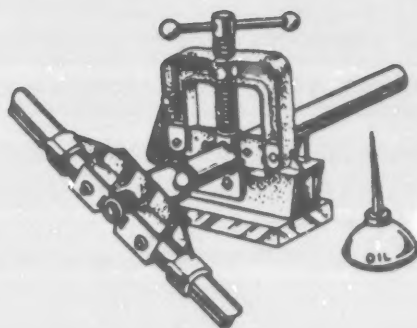
TRANSPARENCY VII-6-H

REMOVING BURR FROM PLUMBING PIPE



TRANSPARENCY VII-6-1

THREADING PIPE



TRANSPARENCY VII-6-J

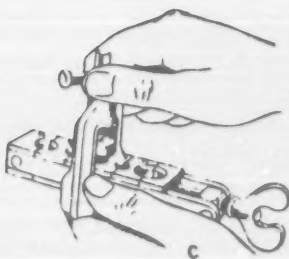
FLARING COPPER TUBING



SLIP TUBING INTO FLARING TOOL AT
THE PROPER SIZE OPENING.



CLOSE DIE BLOCK WITH TUBING
EXTENDING SLIGHTLY ABOVE THE
BLOCK.



PLACE FLARING YOKE OVER THE END OF THE
TUBING AND TIGHTEN HANDLE TO FORM THE FLARE.

TRANSPARENCY VII-6-K

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Farm Structures and Facilities

LESSON 7: Farm Concrete

I. Preparation for Instruction

A. Objectives

1. Terminal: Plan, prepare, and use concrete in the construction of farm facilities.
2. Specific
 - a. Explain the importance of masonry on the farm.
 - b. Identify common masonry tools.
 - c. List the ingredients in concrete.
 - d. Discuss the proper mixing ratios for concrete.
 - e. Estimate the amount of concrete needed for masonry jobs.
 - f. Describe the process of form construction.
 - g. Demonstrate placing, finishing, and curing concrete.
 - h. Explain the importance of having good foundations and footings.
 - i. Demonstrate preparation and use of mortar.
 - j. Demonstrate laying of concrete blocks.

B. Review of Teaching Material

1. Basic Vocational Agriculture II and IV. College Station, Texas: Vocational Instructional Services Center, Texas A & M University, 1978.
2. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Printers and Publishers, Inc., 1977.

3. Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York: Macmillan Company, 1960.

C. Special Arrangements

Contact local farmers to see if they need any masonry work done on their farm such as a slab poured on a small job. If there is a need, coordinate a trip to a farm, with permission, to do the job for that farmer.

D. Material Required

1. Cement, sand, aggregate, water
2. Concrete blocks
3. Masonry tools
4. Mortar mixture ingredients

II. Presentation of Lesson

A. Motivation

1. Discuss importance of proper use of concrete and mortar in construction in terms of poor construction and the results.
2. Illustrate how money can be saved by doing masonry and concrete work yourself.

B. Content Outline

1. Importance of masonry on the farm:

- a. It is adaptable and useful in a wide variety of situations.
- b. It is permanent.
- c. It is sanitary and easily cleaned.
- d. It is fireproof.
- e. It is economical to install and maintain.
- f. It can be used easily by the farmer.

2. Common tools:

- a. Wheelbarrow
- b. Straight-edge or Strike-off rod -- This is used for striking-off the excess concrete from the surface of a poured area. It must be straight and true.
- c. Tamper -- This is used to compact the concrete in flatwork construction after it has been struck off. (Transparency VII-7-A)
- d. Darby -- A darby is a long, flat, rectangular piece of wood, aluminum, or magnesium from 3 to 4 inches wide with a handle on top. It is used to float the surface of a concrete slab immediately after it has been struck off. (Transparency VII-7-B)
- e. Bull float -- A large, rectangular piece of wood or metal 8 inches wide and 42 to 60 inches long with a 4 to 16 foot handle. The function is the same as that of the darby. (Transparency VII-7-B)
- f. Edger -- Edgers are about 6 inches long and are used to produce a radius at the edge of a slab. (Transparency VII-7-C)
- g. Jointer or Groover -- This is usually about 6 inches long with a cutting edge in the center running from 3/16 to 1 inch in depth. It is used to cut a joint part of the way through fresh concrete. (Transparency VII-7-C)
- h. Hand float -- This is usually made of aluminum, magnesium, or wood. They come in various sizes--12 or 16 inches long by 3½ inches wide for aluminum

and 12, 15, or 18 inches long by $3\frac{1}{2}$ or $4\frac{1}{2}$ inches wide for wooden floats. Hand floats are used to prepare the concrete surface for troweling. (Transparency VII-7-D)

- i. Hand trowel -- These range in size from 10 to 20 inches long and 3 to $4\frac{1}{2}$ inches wide. The purpose of steel troweling is to give the surface a dense, smooth finish. (Transparency VII-7-E)

3. Ingredients in concrete:

- a. Portland cement -- This is a manufactured product consisting of a mixture of limestone and clay which is ground and heated until it melts together in a clinker. This clinker is finely ground, forming a gray powder known as Portland cement.

- b. Sand

- c. Aggregates -- These are materials used to give bulk to the concrete.

- 1) Fine -- materials that will pass through a $\frac{1}{2}$ inch mesh screen are called fine aggregate. Sand and crushed stone screenings are included in this category.

- 2) Coarse aggregate -- This material is usually gravel, pebbles, or crushed rock larger than $\frac{1}{2}$ inch.

All aggregates should be clean, hard, and free from foreign material.

- d. Water -- Water should be clean and free from oil, alkali, and acid.

4. Factors influencing strength of concrete:

- a. Quality and amount of cement,
- b. Kind, size, and amount of aggregate used,
- c. Amount of clean water used,
- d. Way the ingredients are mixed and placed, and
- e. Proper curing of the mixture after it is placed.

5. Mixing ratio -- Concrete mixtures are spoken of in terms indicating proportions of the materials. A 1:2:3 mixture would consist of one part (by volume) of

cement, two parts of sand, and three parts of pebbles. This ratio will vary depending on how wet or dry the aggregates are and how the concrete is used. A watertight concrete mixture would have the ratio of 1:1:1 3/4 or 1:1 3/4:2. A slow curing period is required for this mixture. It is very important to use the correct amount of water per sack of cement because excess water weakens the concrete and makes it more porous. For normal exposure, six gallons of water per bag of cement and six bags of cement per cubic yard of concrete is recommended.

6. Estimating concrete needs:

- a. The unit of measure for concrete is the cubic yard. Ready-mix concrete is sold by the cubic yard.
- b. To determine the amount of concrete needed, find the volume in cubic feet of the area to be concreted and divide this figure by 27. The following formula is used for square or rectangular areas:

$$\text{cubic yards of concrete} = \frac{\text{width in feet} \times \text{length in feet} \times \text{thickness in feet}}{27}$$

After computing this formula, add 5 to 10 percent for waste and slight variations.

7. Form construction (Transparency VII-7-F)

- a. Forms are necessary to mold and hold new concrete in shape until it has set. Strong, rigid, and well-braced forms are essential to prevent sagging, bulging, and warping.
- b. Seasoned boards 1 inch thick are often used. They should be smooth, straight and fitted together without cracks. Plywood is also used in form construction because of its strength and large surface area with no cracks.
- c. Bracing and tying are important. Posts (2x4) are placed at about 2 foot spacings. They should be properly braced and tied together to keep the forms from spreading.
- d. It is advisable to spray the surface of the forms with oil prior to pouring concrete to make form removal easier.
- e. Normally, during warm weather, two or three days is sufficient for forms to remain in place for walls

and small projects. In cold weather, they should stay about twice as long. However, in no case should forms be removed until it has been determined that the concrete has thoroughly set.

8. Placing, finishing, and curing concrete:

a. Placing concrete

- 1) Concrete mixture should be placed within 30 to 45 minutes after water has been added.
- 2) Tamp and spade the concrete mixture so it will settle into a solid, dense mass with no air pockets around aggregates, in the corners of forms, or around reinforcing material.
- 3) A spade can be used to work the mixture against the side of the forms.
- 4) A straight edge and level should be used to level the top face of concrete forms.

b. Finishing concrete

- 1) A wooden float is used to smooth the surface of the concrete exposed to the weather.
- 2) After placing concrete proceed with the following steps:
 - a) Initially float with darby or bull float,
 - b) Wait for bleed water to disappear ($1\frac{1}{2}$ - $2\frac{1}{2}$ hours),
 - c) Edge,
 - d) Hand float (magnesium),
 - e) Trowel,
 - f) Broom finish, and
 - g) Apply clear plastic for curing.

c. Curing concrete -- curing improves the strength of the concrete by about 50 percent when allowed to set for 7 days.

- 1) Water curing is done by mist spraying or sprinkling to prevent evaporation of mix water. If this is done, the concrete must not be allowed to dry between applications of water.
 - 2) Curing can also be done by water retaining methods such as covering the concrete with sand, burlap, canvas, or straw. These materials are kept damp during the curing process.
 - 3) Mechanical barriers of waterproof paper or plastic seal in the water prevent evaporation. Additional water is not required with this type of covering. These coverings can be applied as soon as the concrete has hardened enough to prevent surface damage.
 - 4) Concrete should be cured for at least 3 days and preferably a week after it is placed.
 - 5) The most favorable temperature for curing is 55 to 73 degrees F.
 - 6) If freezing occurs within the first 24 hours after placing the concrete, permanent injury to the concrete will occur.
9. Importance of foundation and footing:
(Transparency VII-7-G)
- a. A foundation is designed to distribute the weight of the building and its contents so that the soil can support the entire weight of the structure.
 - b. A foundation consists of the bed (earth giving support), footing (wide part of foundation on the bed), and the wall (part of the foundation resting on the footing).
 - c. Normally the footing is twice as wide as the foundation wall and as thick as the wall is wide.
 - d. Concrete masonry walls are constructed by placing a bed of mortar on the footing to provide a good joint between the footing and block.

10. Preparation and use of mortar:

- a. The purpose of mortar is to bond brick, stone, or blocks together to form strong walls and partitions. The strength of a mortar bond is affected by:
- 1) Quantity and type of cementing material,
 - 2) The plasticity of mortar and its workability,
 - 3) Water-holding capacity of the mortar,
 - 4) Surface texture of the bedding area where mortar is used,
 - 5) Rate of suction of the blocks or units, and
 - 6) Quality of workmanship.
- b. Mortar should be used within 2-3 hours after mixing. If the mixture begins to stiffen it can be retempered by adding a small amount of water and remixing. The ingredients in mortar are sand, water, and a ready mix of cement and hydrated lime. The proportions of materials by volume are:

<u>Cement</u>	<u>Hydrated Lime</u>	<u>Damp Mortar Sand</u>
1 Portland Cement	1 to 1½	4 to 6
1 Masonry Cement	1 to 1½	2½ to 3
1 Masonry Cement plus 1 Portland Cement (heavy load construction)	1 to 1½	4½ to 6

Water is then added until the mixture becomes "plastic" and works well with the trowel.

11. Laying concrete blocks

- a. Place blocks on a pallet to keep them off the moist ground and cover to keep them from getting wet. Blocks must be kept dry before and after laying.
- b. Locate corners and string out the first layer of blocks and align with a chalk line.
(Transparency VII-7-H)
- c. Remove these blocks and place a full mortar bed on the foundation wall. Place corner block

first. Apply mortar to vertical joints before setting them in place. Then place mortar on the thicker surface of the block.

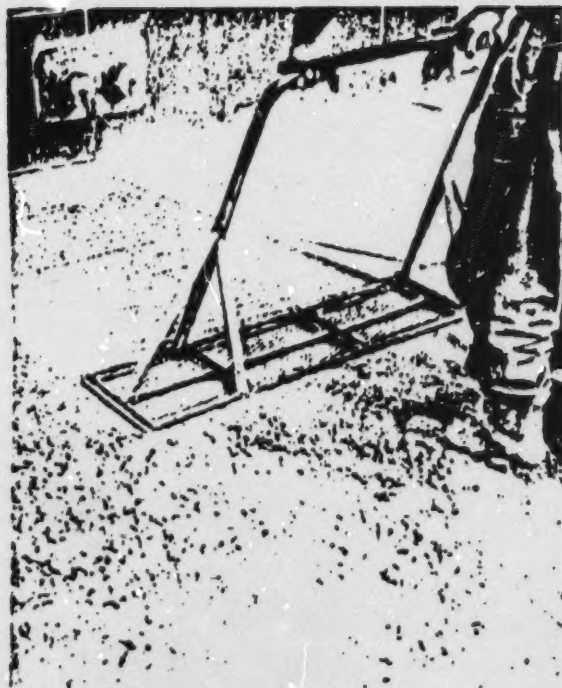
(Transparency VII-7-H)

- d. After laying a few blocks, check alignment and plumbness by using a level. A trowel is used to tap blocks in place. The first course must be level and plumb so succeeding courses will be easier to lay. (Transparency VII-7-I)
- e. Apply mortar on each side of the laid block. Then apply mortar to the vertical edges of the block to be laid.
- f. Lay corners first, making four or five courses higher than the center of the wall. Again, check the wall for being level and plumb. (Transparency VII-7-I)
- g. Lay the blocks between corners by stretching a line so that the top of the course being laid will touch the line. Blocks are leveled and aligned along the course by tapping with a trowel handle as they are set in place. Remove excess mortar and rework it on the mortar board before using the next time. (Transparency VII-7-J)
- h. Close the course being laid by putting mortar on all four vertical edges of the blocks and lowering the closure block into place.
- i. Tool mortar joints when the mortar becomes thumb-print hard. This is done to force the mortar against the block edges and create uniform, clean lines. A $5/8$ inch round bar will produce a concave joint, and a $1/2$ inch square bar will produce a V-shaped joint. Rub the wall with a burlap bag to remove mortar burrs. (Transparency VII-7-J)
- j. Tie bars, embedded in the horizontal joints, are used to connect bearing walls which intersect the face of the main wall. (Transparency VII-7-K)
- k. Nonbearing walls are joined to the main wall by using $1/2$ inch mesh galvanized hardware cloth in horizontal joints of both walls.

C. Suggested Student Activities

1. Students will construct a masonry project on a farm, if arrangements can be made with local farmers.
2. Layout a concrete wall beginning in one corner and extending from that corner 10 feet in both direction at a 90 degree angle from the corner. It should be 5 feet high.

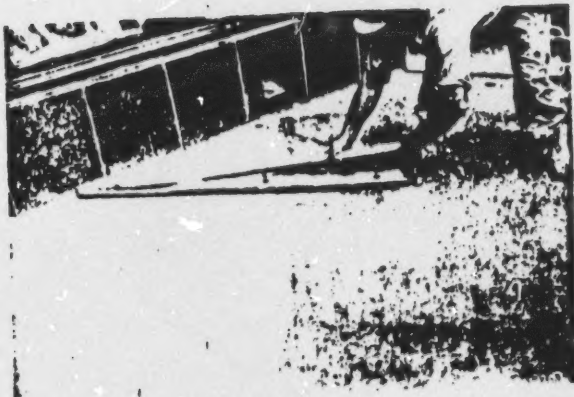
MASONRY TOOLS



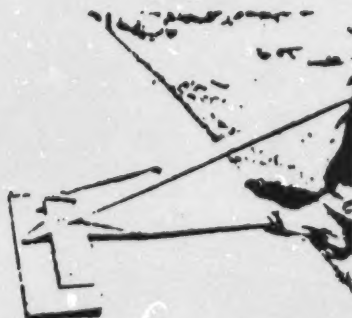
TAMPER

TRANSPARENCY VII-7-A

MASONRY TOOLS



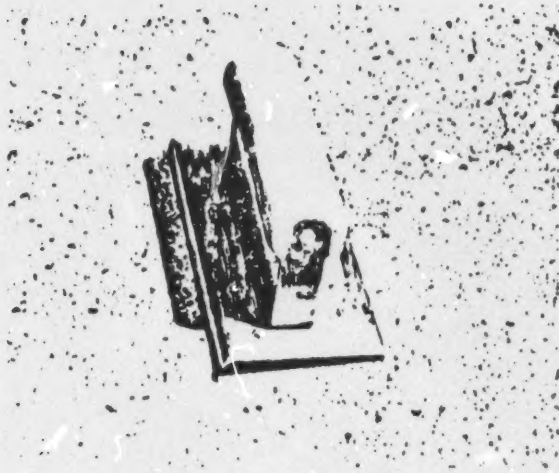
DARBY



BULL FLOAT

TRANSPARENCY VII-7-B

MASONRY TOOLS

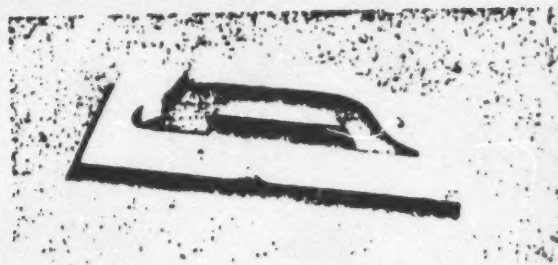


EDGER

JOINTER OR
GROOVER



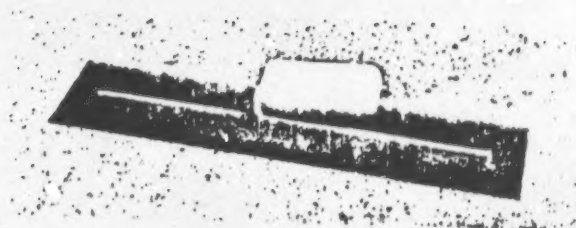
MASONRY TOOLS



HAND FLOATS

TRANSPARENCY VII-7-D

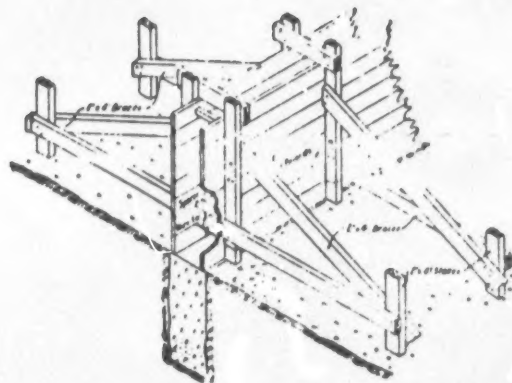
MASONRY TOOLS



HAND TROWEL

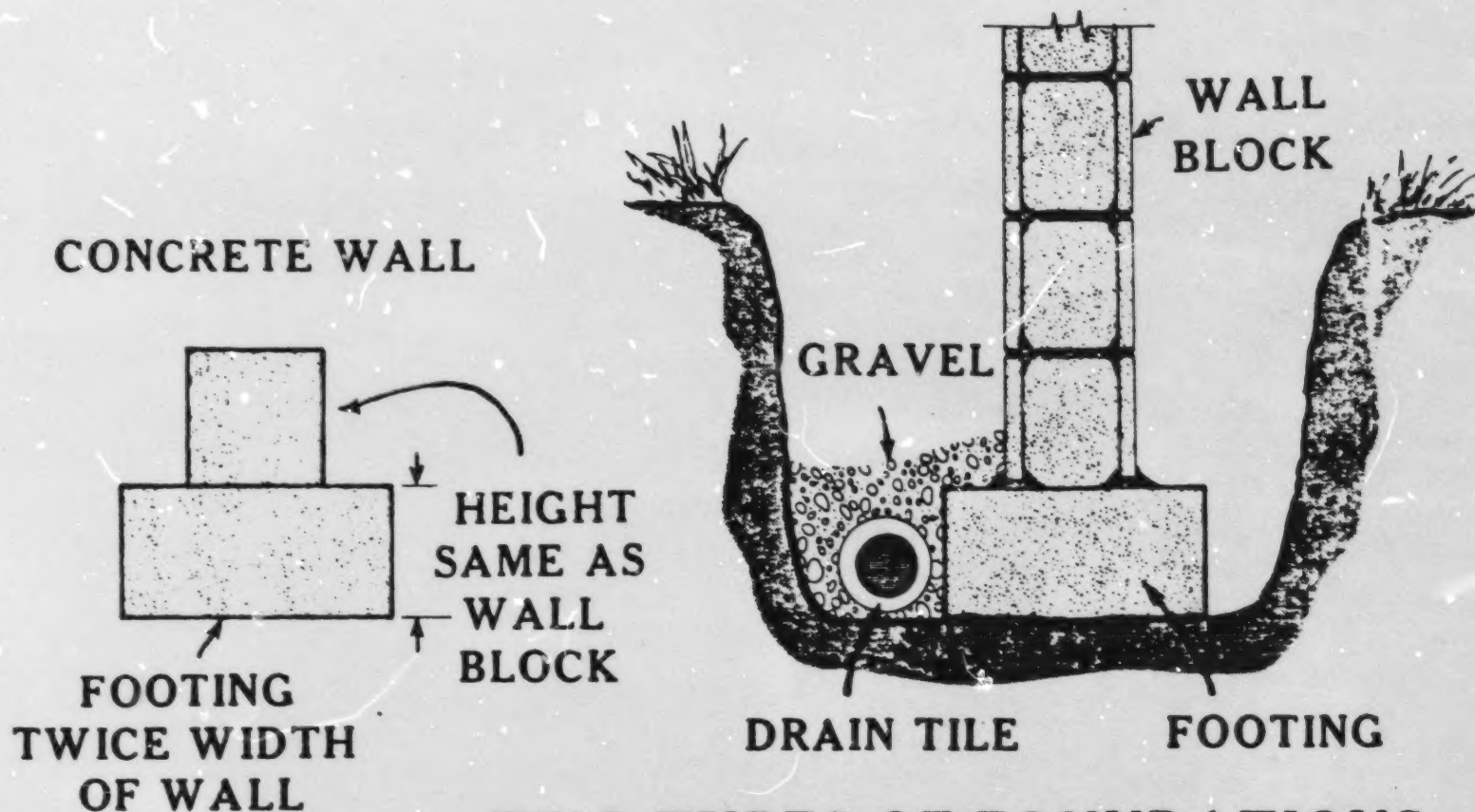
TRANSPARENCY VII-7-E

FORM CONSTRUCTION



TRANSPARENCY VII-7-F

FOUNDATIONS AND WALLS

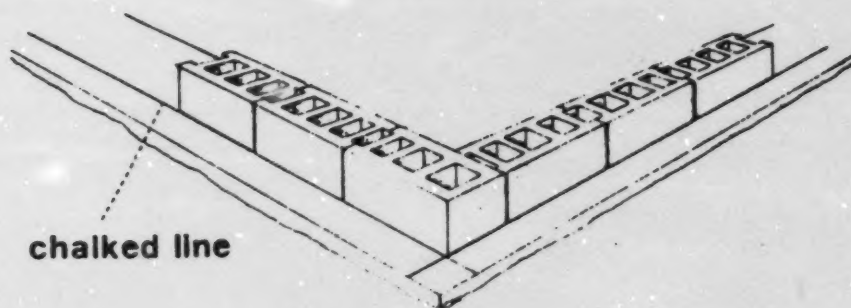


TWO TYPES OF FOUNDATIONS

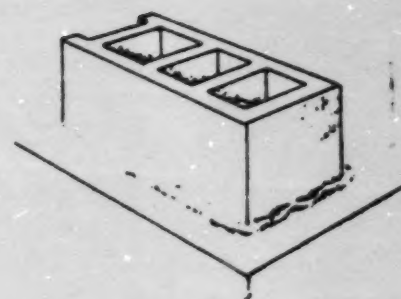
TRANSPARENCY VII-7-G

LAYING MASONRY UNITS

ALIGNING FIRST COURSE

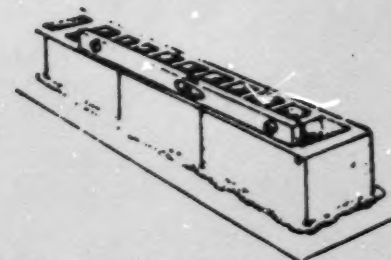


chalked line



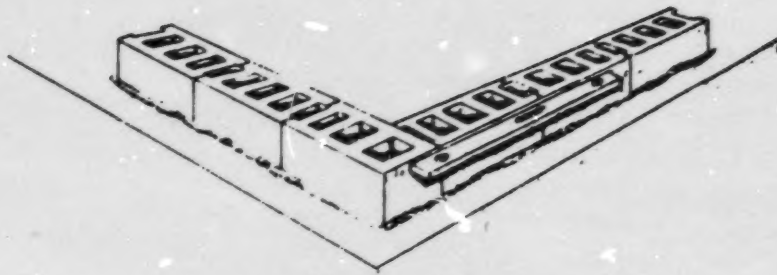
LAY CORNER BLOCK

APPLY MORTAR TO FOUNDATION AND BLOCKS

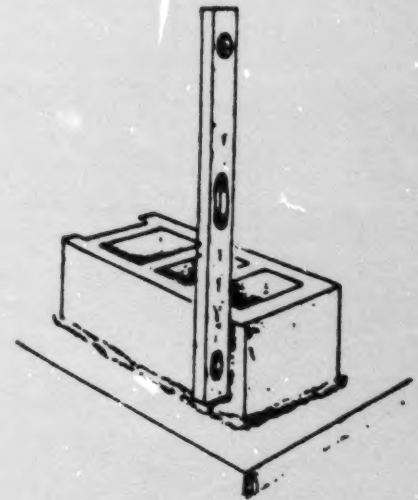


LEVEL BLOCKS

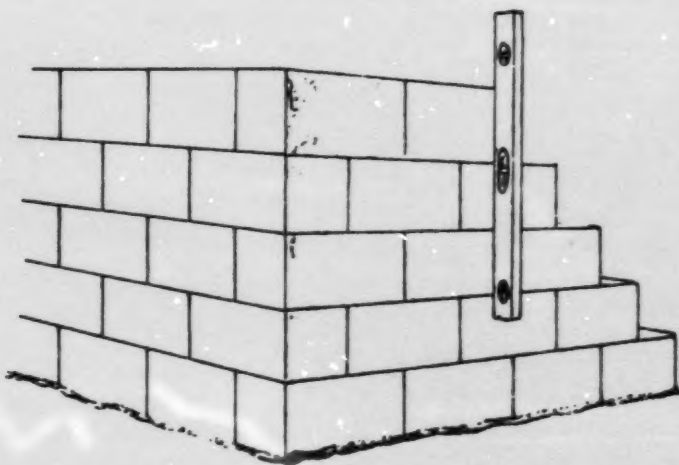
LAYING MASONRY UNITS



ALIGN BLOCKS WITH LEVEL

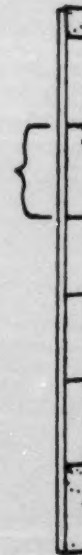


PLUMB FIRST COURSE



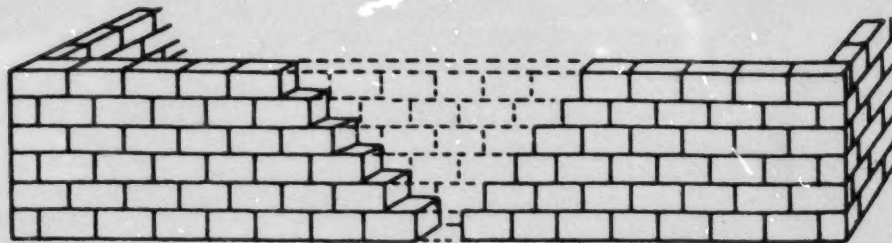
**CHECK PLANE OF WALL-
PLUMB WALL**

8 inches



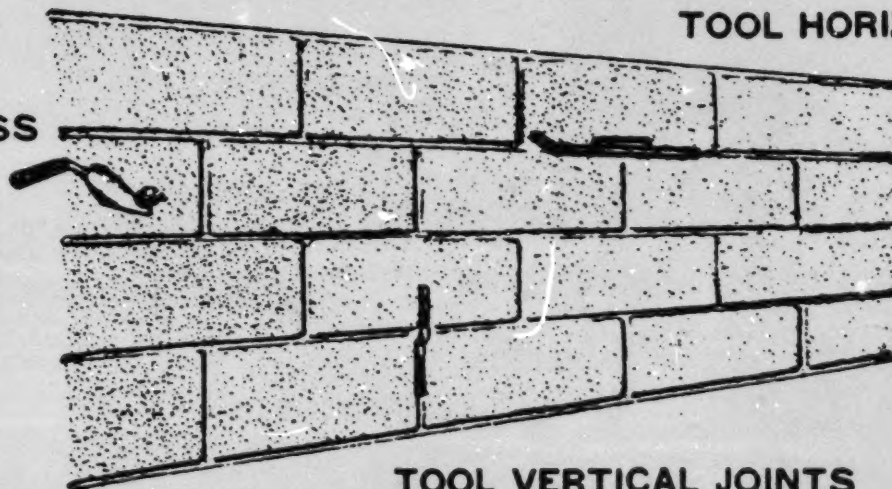
COURSE POLE

LAYING MASONRY UNITS



CLOSE CENTER BETWEEN CORNERS

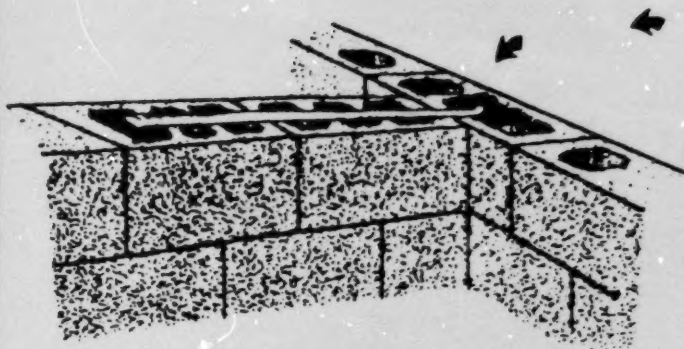
REMOVE EXCESS
MORTAR



TOOL HORIZONTAL JOINTS

TOOL VERTICAL JOINTS

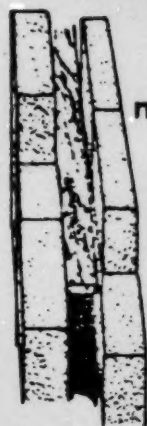
LAYING MASONRY UNITS



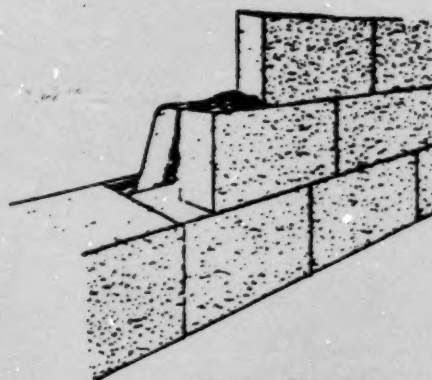
CONNECTING SUPPORTING WALL
WITH TIE BAR



TIE BAR ANCHORED
TO MAIN WALL



CAVITY WALL



SET FLASHING ON
FOUNDATION WALL

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VIII: Cold Metal

LESSON: Procedures for Working with Cold Metal

I. Preparation for Instruction

A. Objectives

1. Terminal: Identify and perform procedures in working with cold metal.
2. Specific:
 - a. Identify common types of metal.
 - b. Demonstrate procedure to cut cold metal.
 - c. Demonstrate procedure to file cold metal.
 - d. Demonstrate the process of drilling holes in cold metal.
 - e. Demonstrate tapping and threading of cold metal.
 - f. Demonstrate selection and use of bolts in cold metal work.

B. Review of Teaching Material

1. Phipps, L. J. Mechanics in Agriculture. Danville, Ill.: Interstate Printers and Publishers, Inc., 1977.
2. Wakeman, T. J. and V. L. McCoy. The Farm Shop. New York: Macmillan Company, 1960.

C. Materials Required

1. Rod for making bolts
2. Assorted nuts, bolts, screws, and washers
3. Assorted sizes of various types of metal
4. Assorted sizes of $\frac{1}{4}$ - $\frac{1}{2}$ inch metal

II. Presentation of Lesson

A. Motivation

1. Show materials that have been welded together and cannot be separated. Emphasize the importance of being able to bolt pieces of metal together rather than weld them. It allows one to change, adjust, and repair damaged parts easily.
2. Demonstrate and discuss the general use of cold metal work in all types of farm machinery and the need for knowing how to work with cold metal.

B. Content Outline

1. Common Types of Metal:

a. Iron

- 1) Cast Iron -- Gray cast iron is used to make engine blocks. White cast iron is used for bearings, plow shares, and moldboards for plows. It is brittle and cannot be bent.
- 2) Wrought Iron -- This iron has most of the carbon removed. It is used to make nails, wire, bolts, pipe, chains, and rivets.

b. Steel

- 1) Mild Steel -- This metal is low in carbon content. It is easily sawed, hammered, filed, or ground.
- 2) Machinery Steel -- This has a slightly higher content of carbon than mild steel. Machinery parts such as plows, beams, and braces are made from machinery steel.
- 3) Tool Steel -- This has a high carbon content. It is used to make cutting tools, hammers, taps, and dies. It is free from impurities but is difficult to weld.
- 4) Alloy Steel -- Metals such as chromium and nickel are added to steel to give it certain desirable traits.

c. Aluminum -- It is a lightweight metal used for siding, roofing, wire, etc.

d. Copper -- This is used primarily in plumbing and electrical wiring. Combined with zinc or tin, it becomes brass or bronze alloys.

e. Tin -- It is a soft, silvery metal used to coat cans, utensils, and metal roofing.

2. Cutting Cold Metals: (Transparency VIII-1-A)

a. Cutting Tools

- 1) Hack Saw -- This tool can be used to cut mild steel, hard steel pipe, or sheet metal. Place the metal in a vise close to the measuring mark. Begin the saw by pulling backwards until

a saw kerf is started. Normally, 40-50 strokes per minute are considered the correct speed for sawing.

2) Cold Chisel -- This type of tool cuts metal by "shearing" metal apart at the point of contact between the chisel and metal. A standard flat chisel is shaped at a 70 degree angle. (Transparencies VIII-1-B and C)

3) Bolt Cutters -- The fastest method of cutting round iron is to use bolt cutters. However, hardened steel should not be cut in a bolt cutter.

b. Cutting Different Types of Metals (Transparency VIII-1-C)

1) Tool Steel -- Normally, tool steel is broken by sawing $\frac{1}{4}$ the way through the rod or bar and breaking it in a vise with a hammer.

2) Thin Metal -- This metal can usually best be cut by using metal snips and metal cutting shears.

3. Filing Cold Metal:

a. Types of files by shape (Transparencies VIII-D and E)

1) Mill -- Made with only single cut teeth. They are 4-16 inches in size.

2) Flat -- Similar to mill files.

3) Square -- This file has four filing sides instead of two as with the mill.

4) Round -- This is round in shape and tapers from shoulder to the point.

5) Half-round -- This file has one flat and one round side.

6) Taper -- This is primarily used for sharpening saws. The triangle, cantsaw, and crosscut files are the most popular. A three-cornered file is a tapered type.

b. Procedure for filing (Transparencies VIII-1-E and F)

- 1) Stand facing the work so that pressure can be applied on the forward stroke.
- 2) For flat surface filing, hold the file at a 90° angle to the side of the stock.
- 3) About 30 strokes per minute is the proper speed to file metal. Always lift the file on the back stroke.

c. Clean the File (Transparency VIII-1-F)

- 1) Small particles of metal are easily removed by rubbing the file with chalk before filing. A regular file card is used to clean the teeth. Brushing should be parallel to the teeth.
- 2) Keep files away from moisture. Avoid dropping the file or hitting it against other tools as this will damage the teeth. Store in a dry place.

4. Drilling Holes:

a. Types of Drills

- 1) Portable electric drill -- Good for drilling metal less than $\frac{1}{2}$ inch thick.
- 2) Hand drill -- This drill is usually used for drilling holes $\frac{1}{4}$ inch or less. It is used for light metal work.
- 3) Breast drill -- This drill is used to make holes in cold metal up to $\frac{1}{2}$ inch.
- 4) Post drill -- This type of drill is used to drill large holes in metal. It is slow because it is turned by hand.

b. Types of Drill Bits (Transparency VIII-1-G)

- 1) Flat -- This bit is flat on both sides with two cutting edges.
- 2) Straight-fluted -- This bit has two straight flutes extending the length of the body.
- 3) Twist -- This is most commonly used in metal work.

c. Drilling a Hole (Transparency VIII-1-H)

- 1) Mark a cross(x) with a scratch awl at the center of the hole to be drilled in the metal.
- 2) Mark it for drilling with a center punch making sure it is centered where the two lines cross.
- 3) Select the proper size and type of twist drill. Secure the drill bit in the drill chuck.
- 4) Secure the work to be drilled in a vise or clamp.
- 5) Apply a lubricant to the drill and hole while drilling.
- 6) Use a steady pressure while drilling and let up as the point begins to pierce the other side of the stock.
- 7) Remove chips and shavings with a brush, blunt tool, or air. These may accumulate and cause a drill to be twisted and broken.

5. Tapping and Threading:

a. Tools (Transparencies VIII-1-I and J)

- 1) For threading, tools required are dies, die stock (handle), vise, file, and oil.
- 2) For cutting threads in holes, tools required are taps, adjustable top wrench, reamer, file, and oil.

b. Threading a Bolt or Rod (Transparency VIII-1-K)

- 1) Bevel the edge of the bolt.
- 2) Place the bolt in a vice.
- 3) Select the proper die, place over the bolt (guide first), and apply pressure which is turning clockwise.
- 4) Apply lubricant about every third turn.
- 5) Back die up $\frac{1}{4}$ turn to remove chip and loose metal. Remove the majority of the chips from the flute before removing die from the bolt.

- 6) It may be helpful to screw the die on a bolt of the same size diameter and threads to see if it is the correct die.

c. Tapping a Hole (Transparency VIII-1-K)

- 1) Select proper twist drill for the size hole to be threaded.
- 2) Secure the stock in a vise or with clamps.
- 3) Apply downward pressure on the top while it is turned. Pressure is released after it takes hold of the metal.
- 4) Apply lubricating oil during the process.
- 5) Clean top flute before removing it from the hole.

d. Three Types of Threads

- 1) N. C. taps and dies are used for National Course threads (used on bolts and rods in farm machinery).
- 2) N. F. taps and dies are used for National Fine Threads (used on tractors, cars, trucks).
- 3) NPT taps and dies are used to cut National Pipe Threads.

6. Bolts

a. Purposes

- 1) To fasten metal to metal or to fasten metal to other types of material
- 2) To give strength to an object
- 3) To make disassembly easy
- 4) To fasten covers that conceal engine parts
- 5) To make adjustments on machinery
- 6) To reduce the cost of welding and cutting

b. Types of Bolts (Transparency VIII-1-L)

- 1) Machine bolts -- These bolts have square or hexagonal head. They are used primarily in assembling machinery.

- 2) Stud bolts -- These are bolts without a head and are threaded at each end. It requires a nut on each end if used in an unthreaded hole.
- 3) Carriage bolts -- These are used primarily to join metal to wood. This bolt has a square shank that sinks into the wood to keep the bolt from turning while the nut is being tightened or removed.
- 4) Machine screws -- These are used in threadless holes and require nuts to be used for tightening.
- 5) Stove bolts -- These bolts are threaded the entire length of the bolt and are used to fasten metal to metal.

c. Bolt Threads

- 1) Machine bolts -- NC and NF
- 2) Carriage -- NC
- 3) Cap Screws -- NC and NF
- 4) Machine Screws -- NC and NF
- 5) Stove Bolts -- NC
- 6) Stud Bolts -- NC and NF

d. Types of Washers (Transparency VIII-1-M)

- 1) Flat washers are used to protect the metal or other material from the bolt thread of nut.
- 2) Lock washers form a tension between the nut and the material to prevent the nut from loosening and backing off the bolt.

e. Procedure for Using Bolts

- 1) Place the proper bolt in the hole that has been drilled in the metal.
- 2) Nuts are drawn tightly when bolting metal together. Over-tightening may stretch or twist a bolt.
- 3) Bolts on vibrating machinery are tightened with lock washers under the nuts. Flat washers are used between the nut or bolt head and the wood.

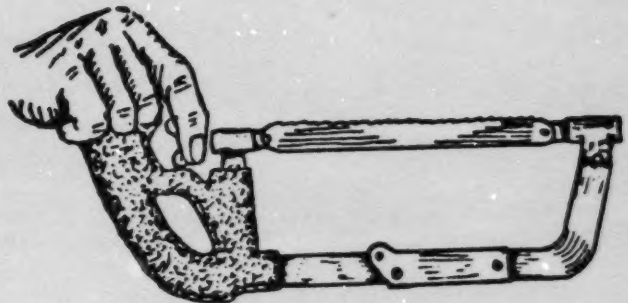
C. Suggested Student Activities

1. Allow the class to make two displays on cold metal. One display would be constructed to illustrate the different types of metals with a specimen attached to the display board. Each specimen would be labeled appropriately. The second display would illustrate the different types of bolts, screws, nuts, and washers used in cold metal work. Specimens for this display would also be attached to the display board.
2. Each student should be allowed to drill holes, use tap and die to make bolts and create threads in the holes, and connect two pieces of metal together in a prescribed exercise at the direction of the instructor.

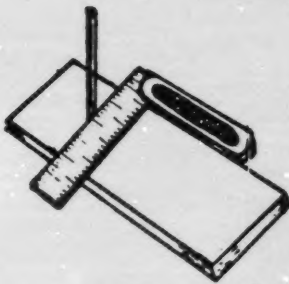
CUTTING COLD METAL WITH HACK SAW



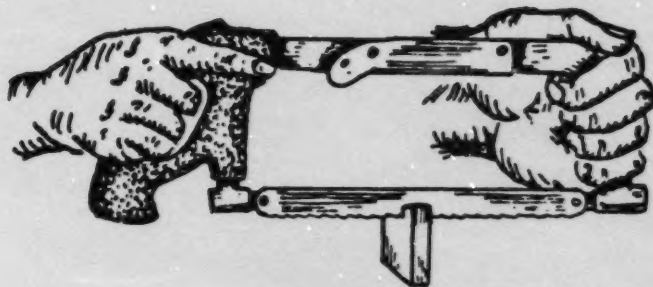
**Inserting Blade
Teeth Forward**



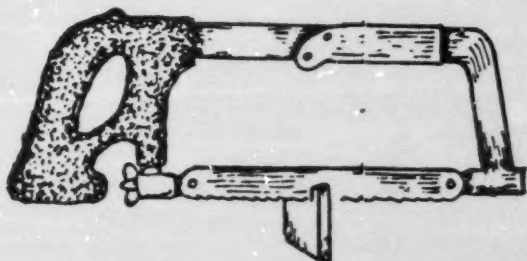
**Tighten Blade
Firmly**



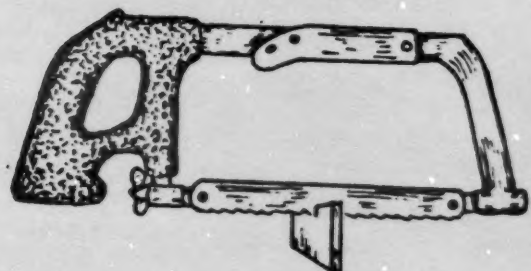
Marking Stock



Using Both Hands

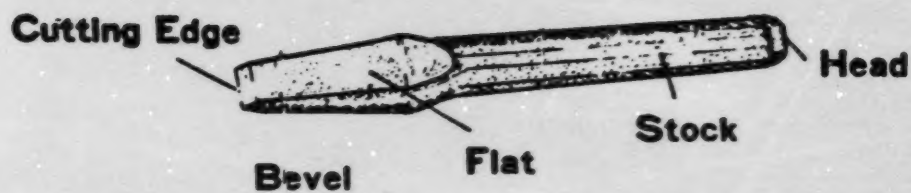


Use Pressure Forward Stroke

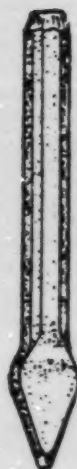


No Pressure On Back Stroke

USE OF COLD CHISEL



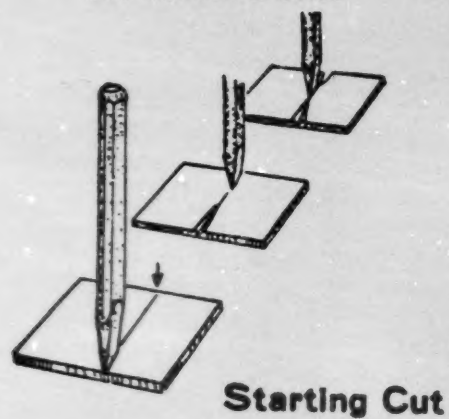
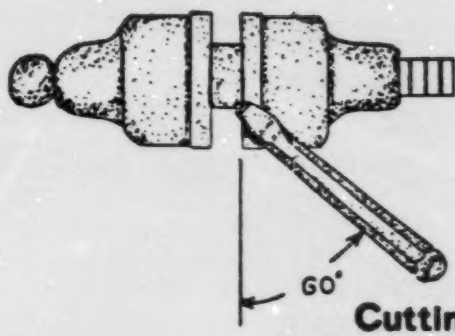
Cape



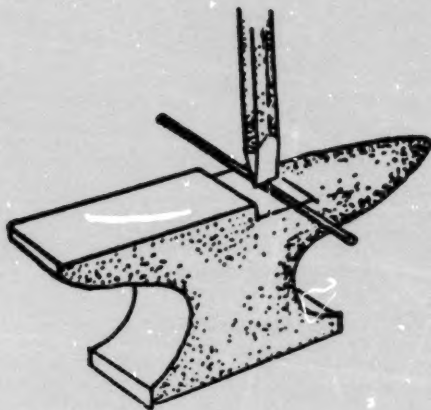
Round Nose



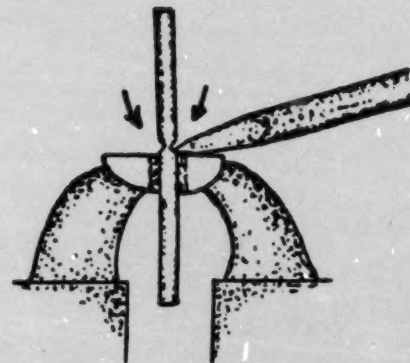
Diamond Point



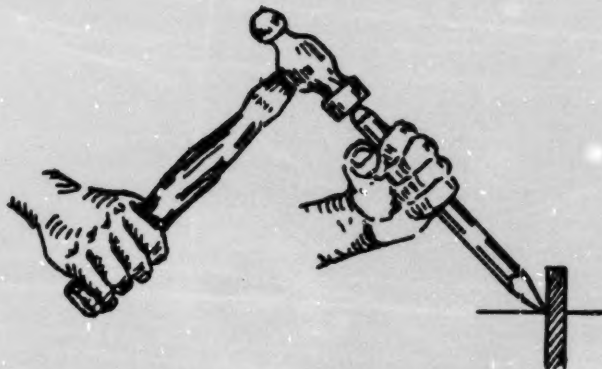
USE OF COLD CHISEL AND BOLT CUTTER



Cut Metal on Anvil Ledge



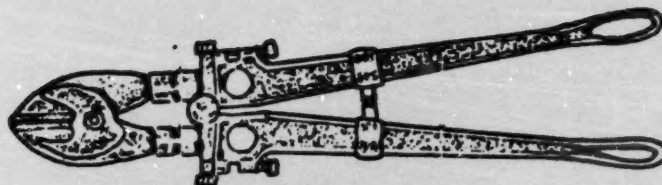
**Cut Two Sides of
Rod Before Breaking**



Use of Ball Peen Hammer with Chisel

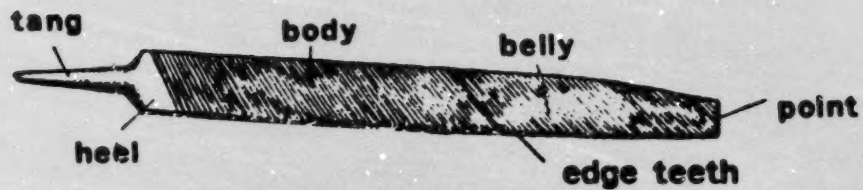


Slitting Chisel

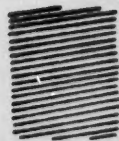


Bolt Cutter

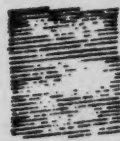
SELECTING FILES



SINGLE CUT TEETH



bastard cut

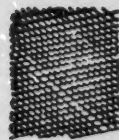


second cut

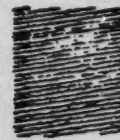


smooth cut

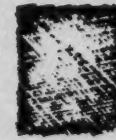
DOUBLE-CUT TEETH



bastard cut



second cut

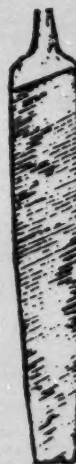


smooth cut

TYPES OF FILES



mill



flat



square

SELECTING AND USING FILES



round

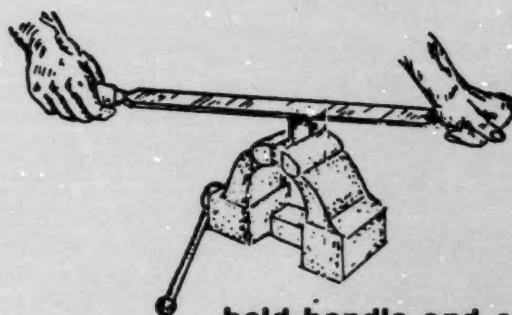


half-round



tapered

position for filing

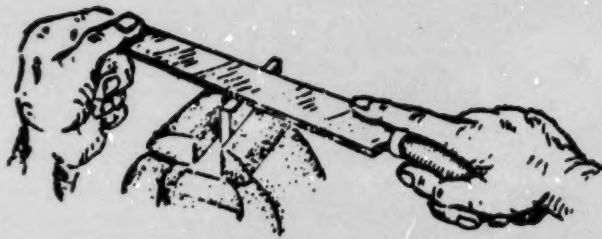


**hold handle and end
firmly-heavy work**

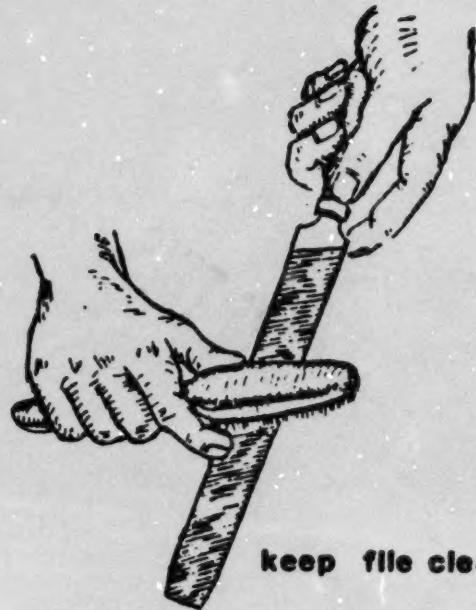


TRANSPARENCY VIII-1-E

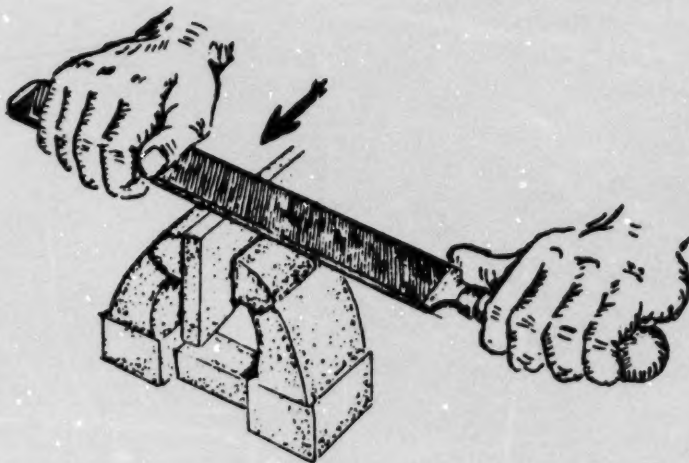
FILING PRACTICES



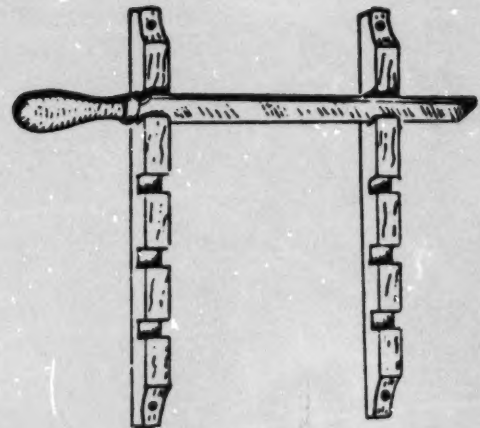
hold handle and end
firmly—light work



keep file clean

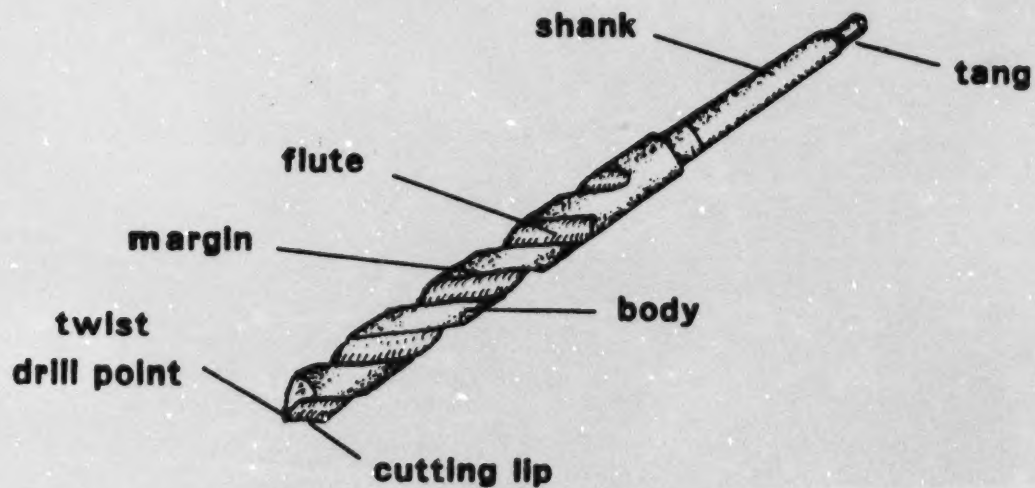
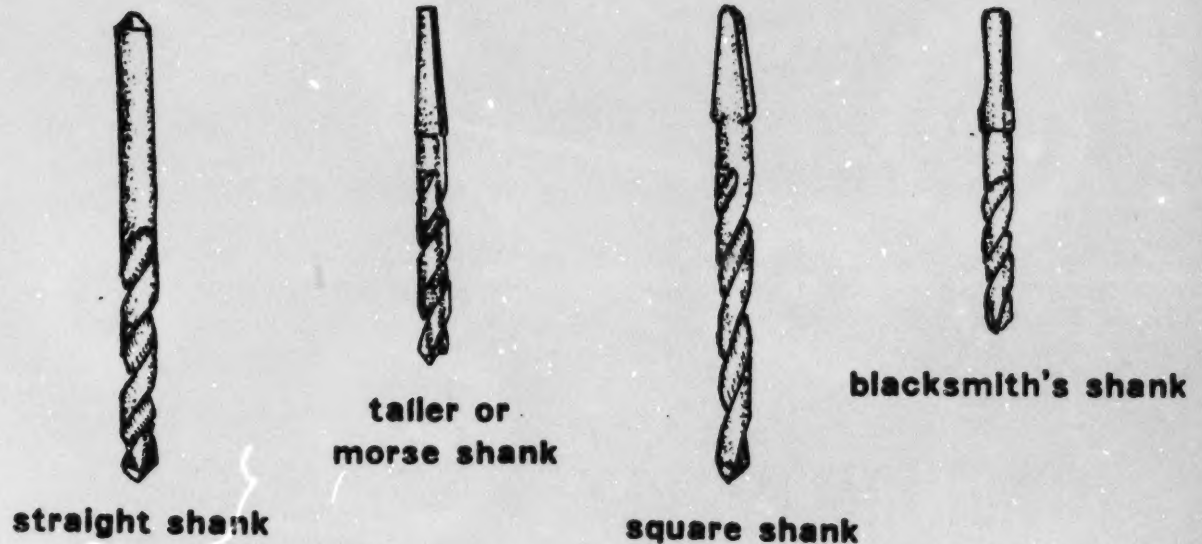


drawfiling



proper storage for files

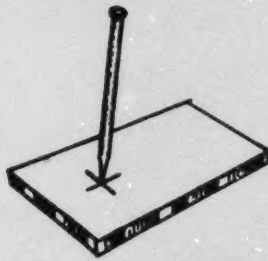
TWIST DRILL SHANKS AND PARTS



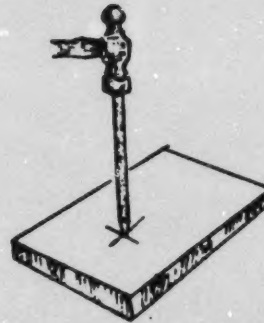
TWIST DRILL PARTS

TRANSPARENCY VIII-1-G

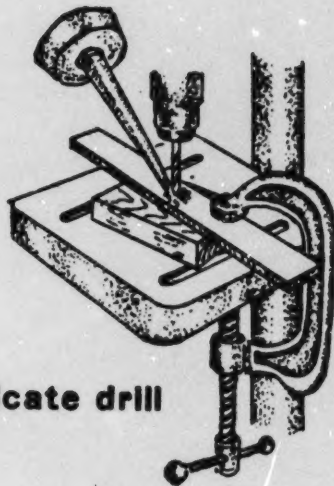
DRILLING A HOLE IN COLD METAL



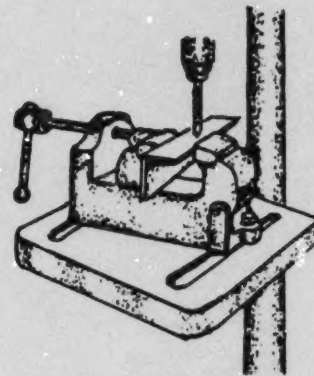
center by making a cross



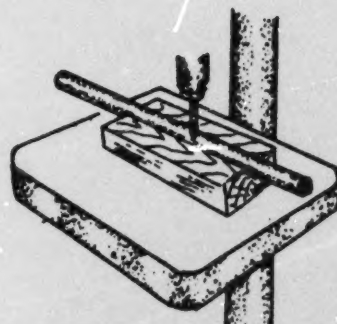
dent with center punch



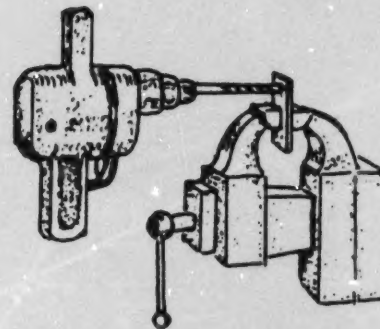
lubricate drill



vise for drill press

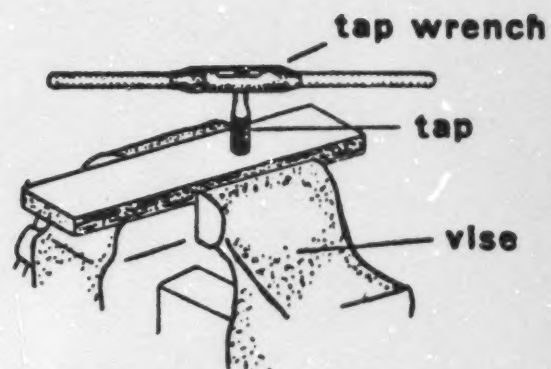
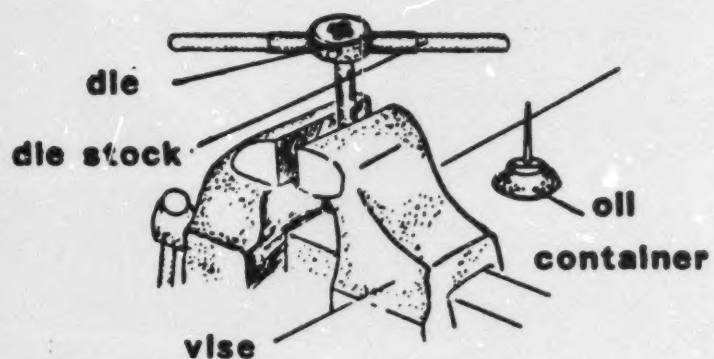


drill round metal
with V-block



hold metal in machinist's
vise when hand drilling

TOOLS FOR THREADING AND TAPPING



TAPS



BOTTOMING TAP



PLUG TAP



TAPER TAP

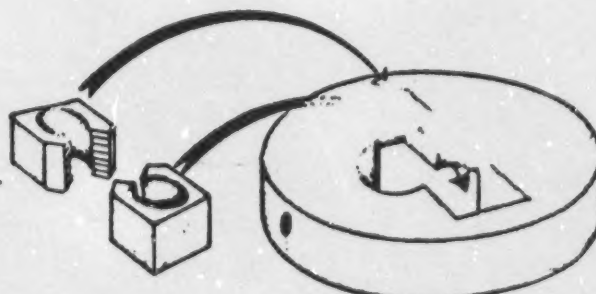


SPLIT DIE



SOLID DIE

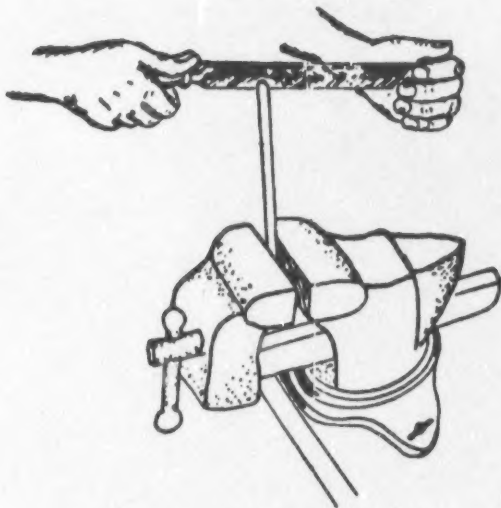
**TWO PART
DIES**



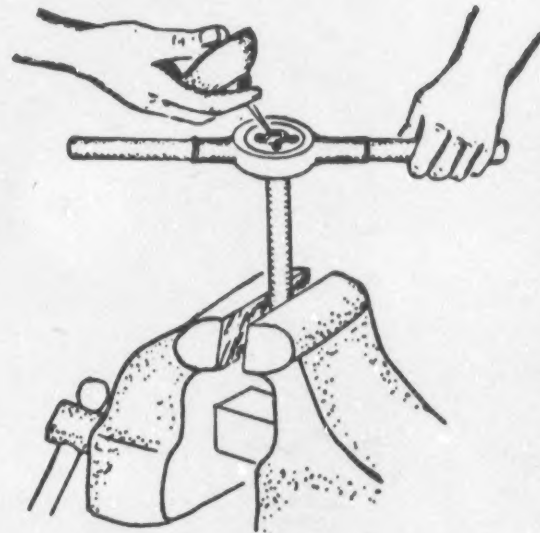
COLLET

DIES

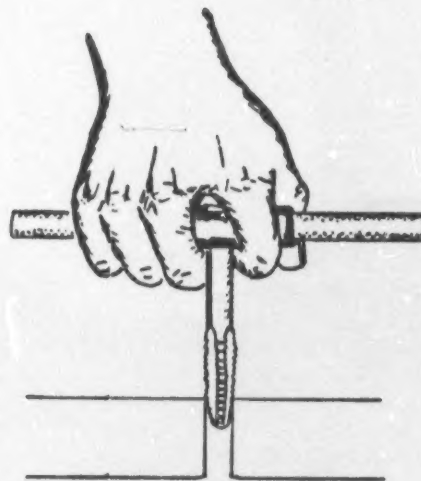
THREADING AND TAPPING



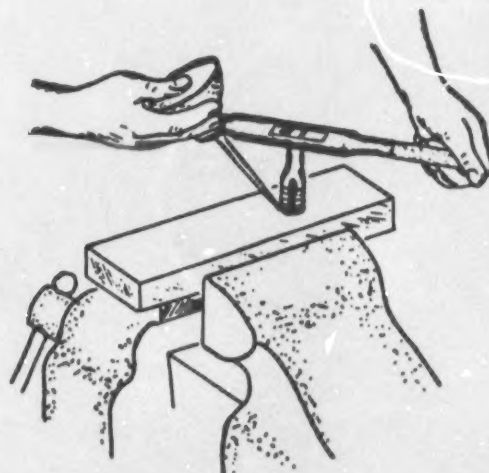
beveling the edge



lubricating the die



**tapping a hole
starting tap straight**



lubricating the tap

BOLTING IN METAL WORK



machine



stud



carriage

BOLTS



MACHINE SCREWS



flat



round



fillister



hexagon



socket

TAPPING SCREWS



national fine (UNF) threads



national coarse
(UNC) threads

CAP SCREWS

TRANSPARENCY VIII-1-L

WASHERS AND NUTS



flat washer



helical spring type washer



external lock washer



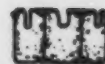
internal lock washer



hex nut



hex nut



**double chambered
hex nut**



washer faced (WF) hex nut

